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January 1984 Rs. 4

SCIENCE TODAY

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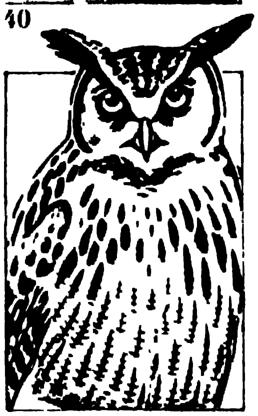

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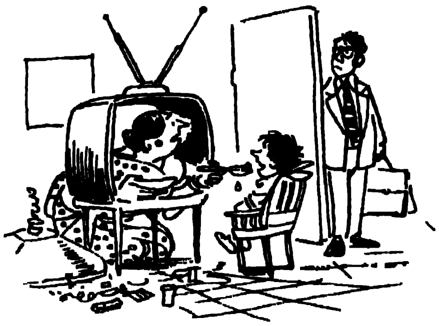
Also:

If they persist, we will have to bomb them ultimately to save our missile deployment programme!



He doesn't eat otherwise!

The evil spirit is not responding to my magic. It must be common cold. Take these aspirin tablets four times a day

I swear, doctor, I just hit it with this in pure self-defence!

SCIENCE TODAY

Vol 18 No.1
January 1984

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THE onset of winter usually coincides with the mushrooming of a large number of scientific symposia in India. The salubrious climate provides a welcome getaway for delegates from the western hemisphere troubled by the inclement weather. International participation, which appears to be almost a prerequisite, is thus assured. The size of these gatherings varies but the basic framework is almost constant. What such seminars accomplish is a broad question meriting serious discussion. But we will leave that for another occasion. We would, however, like to draw attention to another disturbing aspect of these meetings.

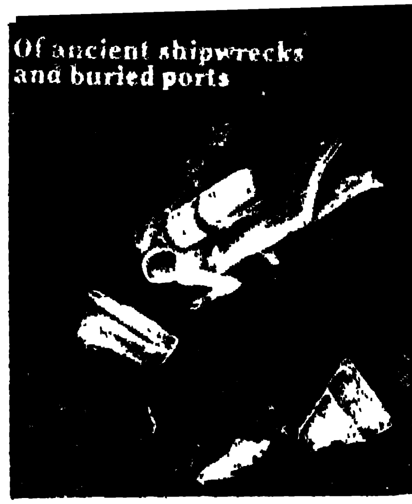
These symposia are flagged off with inaugurals which are something of a cloned ritual. A minister, equally eager to boost his image by hobnobbing with scientists, is invited to inaugurate. In the unlikely event of his not being available, a technocrat secretary to a government department is an amenable substitute. Then there is a chief guest who is normally a science manager. A senior scientist well past his prime also graces the dais. The director of the host institute welcomes the delegates. Someone anxious to ascend the scientific hierarchical ladder is generally the organising secretary and proposes the vote of thanks.

Equally predictable are the proceedings of these functions. The minister reads out a speech written more often than not by his technocrat secretary. The speeches reflect the platitudes adopted by the technocrat to become acceptable in the corridors of power. Essentially they refer to the social conditions, need for uplift of the downtrodden and sign off with a sermon to the scientist-delegates to be conscious of their social obligations. Scientists are exhorted to leave their much-pilloried ivory towers and conduct socially relevant if unglamorous studies. And yet if someone taking this seriously were to submit a proposal for precisely such basic field studies he would be in for a shock! For routinely, such proposals get turned down almost by a reflex action with a rejoinder to do frontier research.

The chief guest also gets in the act and opines that the present day craze for carrying out sophisticated studies requiring modern techniques and equipments is highly deplorable. The delegates are asked not to forget the simple, yet elegant basic methodologies which still provide the most correct and accurate information. Usually time and advances in science have bypassed the pontificating gentleman who finds himself all at sea in the midst of contemporary science.

Time has come, we believe, to have an objective introspection. Are these inaugural functions really necessary? Why shouldn't the one with the most interesting paper be invited to provide the proper take off for the proceedings? We need no pursuasion to be convinced of the importance of exchange of information. But that purpose is hardly likely to be served by holding mammoth jamborees. A dozen persons or small groups actively working on a problem getting together would be far more profitable. The money spent on these meetings is not trifling. It could be utilised more gainfully by developing literature search services and by speedier dissemination of the most current information. A true symposium is one which stimulates thought and opens new approaches.

EDITOR



DWARKA AND MAHABHARATA

"I would like to answer some of the issues raised by Prof. H. D Sankalia questioning the link between my recent Dwarka excavations and the *Mahabharata* in the box item in my article on "Sunken ships and submerged ports" in September 1983.

Earlier, Prof Sankalia and his colleagues in the Deccan College, Pune, after their excavations at Dwarka in 1963, had unequivocally said that it was the Dwarka of the *Mahabharata*. Even though their excavations did not yield evidence of habitation earlier than the 1st century BC at Dwarka, they did consider it as the Dwarka of the *Mahabharata*, which automatically suggests Yadava association since they have relied on the *Mahabharata* and the *Puranas*. I quote from their report on Dwarka (1966):

From our observation of the various places in and around Dwarka as also from the evidence of excavation, one can definitely say that this is the Dwarka mentioned in the Musalaparva of the Mahabharata, *the* Dvarakamahatmya *of the* Skanda Purana *or the other* Puranas *and the* Ghata Jataka *In particular, one can say that the Dwarka described in such a great detail as a sacred tirth by the Harivamsa probably came into existence after the second submergence by the sea of the two earlier Dwarkas* . (Excavations at Dwarka, *Bulletin of the Deccan College, 1966, page 17*, by Ansari and Mate with a preface by Sankalia)

I conducted onshore excavation in 1979 and 1980 on behalf of the Archaeological Survey and offshore excavation for the National Institute of Oceanography in 1983 I found positive evidence of habitation remains of the 15th to 10th centuries BC and submergence of townships earlier than those encountered in the 1963 dig All these evidences have been accepted by Sankalia who says· "That there was habitation in the Dwarka area during the 15th century BC or earlier, as shown by the excavations, is true the area had been inhabited by the Harappans, the Lustrous Red Ware people and later by others" (SCIENCE TODAY, September 1983, page 23). But still, he says that "one must establish that Krishna and the Yadavas did indeed go to Dwarka in Saurashtra from Mathura" For migration, archaeologists have to rely on the Epic and Puranic references as the Yadavas cannot be said to have carried pottery from Mathura to Dwarka. They would have used the local ware of the 15th-14th centuries BC.

About the need to find the Painted Grey Ware (PGW) in Saurashtra for proving the *Mahabharata* link it must be emphasised that the Painted Grey Ware is dated 10th-4th centuries BC. whereas the generally accepted date of the *Mahabharata* War is 1424 BC and not 984 BC (see S. B. Roy: *Date of Mahabharata Battle* (Delhi 1976); P. Banerjee. *The Life of Krishna in Indian Art* (Delhi 1978); and B. B. Majumdar: *Krishna in Legend and History* [1969]). In his recent researches, N. Mahadevan, who has analysed Puranic and astronomical evidence, has come to the same conclusion. It is the late Harappan and the post-Harappan wares, which fall in the time bracket of the 16th-14th centuries BC and have a wide distribution in Saurashtra, Punjab, Sind, Haryana and northern UP, that have a better claim than the PGW for being considered as the cultural trait of the *Mahabharata* period. Further, at Hastinapur and other places the pre-PGW known as the Ochre-Coloured Pottery (OCP) comes within the chronological bracket of the *Mahabharata* (15th century BC) since it is found to have generic affinity with the late Harappan ware.

Prof Sankalia asks whether the Yadavas are mentioned in Indus seals. The *Rigveda* refers to the Yadus whose descendants are the Yadavas. The Vrshni clan to which Krishna belonged and was the 58th in the line seems to have been referred to by the names or epithets Vrsha, Vrshan, etc in Indus seals.

On this evidence, it can be safely concluded that the Post-Harappan Lustrous Red Ware people who lived in Dwarka, Bet Dwarka, Prabhasa, Rojdi (Srnathgadh), etc which were fairly large towns, similar to the large towns mentioned in the *Mahabharata*. answer the description of the *Mahabharata* people. Elsewhere, the OCP and other post-Harappan wares may represent their culture, especially if the associated copper hoards are taken into account

National Institute of Oceanography Dona Paula Goa

S. R. RAO

Dr Rao ignores that in my introduction to our Dwarka report, I have clearly mentioned what Dwarkas we had possibly excavated. However, it is difficult, nay impossible, to assign any of these or what Dr. Rao has later excavated to Krishna or the Yadavas. This for the simple reason that we cannot yet place these people to any definite period of history or pre-history; the *Mahabharata* we have today is very much inflated This has been shown by the critical editors of the *Mahabharata*; Prof. Edgerton of Chicago University, who edited the *Sabha Parva* dated it after the 1st century AD-BC. because it mentions Roma which cannot be the earliest Rome (7th century BC) when we had excellent trade with Rome. Historical and archaeological studies by myself and two of my pupils, Dr Chapekar and Dr. Gauri Lad, have definitely proved to what various periods we can date this or that item, for instance, Subhadra's silk sari cannot be earlier than the 3rd century BC Even orthodox Sanskrit scholars like Prof. K K. Shastri of Ahmedabad have boldly reduced the *Mahabharata* (see his *Jaya Samhita*, that is *Ur-Mahabharata*, 1977); and even this, I have shown in my review, contains many late historical incidents.

Again, it is not clear to what period of *Mahabharata* Dr. Rao assigns his latest discoveries. For according to him, the Harappans had the first non-violent empire in the world. This, as I pointed out to him goes against definite archaeological evidence like fortifications at Harappa, Mohenjodaro and elsewhere, and the occurrence of sling balls, and bone arrowheads. And Krishna, as we know, had to fight many wars. Until the Harappan script is satisfactorily read, all these problems and contradictory views will continue to be propounded.

Deccan College Pune 411 006

H. D. SANKALIA

Halt! the mad nuclear arms race

The article "The nuclear arms race hots up" (September 1983) was rational in its approach towards the most crucial problem of our times—the need to eliminate the danger of war in general, and that of a nuclear one in particular. Dr. R. R. Subramanian correctly states, "developments in the area of high-energy lasers, charged particle beams and advanced microwave devices may signal the emergence of war in outer space".

Is it not the most sacred duty of all scientists, media men and men and women of goodwill to impress upon world statesmen the urgent need for banning military arms stock-piling in outer space? In this respect, one appreciates the initiative of the Soviet President, Mr. Yuri Andropov, in unilaterally renouncing the placement of war-heads in outer space.

The economics of the nuclear arms race should set all people thinking as to what can be done to halt the manufacture, stock-piling and possible use of nuclear weapons by any country. Unfortunately, the war economy of the USA is the single most discouraging road block on the path of disarmament. The MX missile project has been denounced by lakhs of peace-marchers in New York and other European cities.

It is time our conscientious scientists and peace campaigners mobilised public opinion to strengthen the force of peace in the world. The mad nuclear arms race must be ended!

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Ms VINEETA SINGH

Computer piracy—a suggestion

Adi Shamir's invention of a technique to lock software in diskettes in SSL (November 1983) made no mention about the July 1983 issue of the IEEE on "Computers". It had covered a major topic on the techniques for preventing software crime. Yet the problem still exists for the software codes stored in solid state memories, namely PROMS, which form the major portion of microprocessor-based systems. It is possible to envisage a simple hardware/software method for locking the PROMS using digital comparators, latches and floating gate cells of the PROM itself. Software then involves manipulation of a few security codes. This hardware fabricated on chip adds some intelligence to the memory and does not augment the cost of the chip as such.

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Tamil Nadu

B. SRINIVASA RAO

Soft soaping with animal fat?

This refers to the item 'Beef tallow in vanaspati' in Science Shapes Life (October 1983). No one to date has raised the issue of the use of mutton tallow in soap making. My mother remembers that during the British rule, Sunlight soap was imported, and it carried the declaration that a prize in cash (Rs. 10,000) will be given to any person who proved the use of mutton tallow in soap. This was continued till 1960 on wrappers of Sunlight soap.

Sambalpur
Orissa

MRS. MANGALA GOWARDHAN

Sci-fi feedback

For those who have read *Warp* by Ralph Norton, first published in 'Mayfair' some years ago, reading Jayant Narlikar's "The Rare Idol of Ganesha" (September 1983) must have been disappointing. One would have expected something more original from a renowned scientist.

By comparison, Bal Phondke's "The Southpaw Strain" (November 1983) has an original twist to the same theme. This theme of sinister-dexter imaging has been a favourite of many sci-fi authors, and as a result, many original and interesting tales have been published.

Pir Court
111 Queens Road,
Bombay 400 020

SULAEH FATEHI

Your "The Southpaw Strain" is a beautiful piece of SF which encompasses life disturbed through the pathological problems of warring microbes. A good SF resonates life and puzzles the reader and your story achieves this nicely.

Though triggered through the concept of 'mirror image' injected by Dr. Narlikar, your SF dwells independently on the principle of dextra rotation of pathogens bearing the Gram weightages +ve/−ve, etc. The idea of celebrating the Quit India movement is subtle and induces a sharp sarcasm.

Mathure Bungalow
Gamdevi Maidan Road
Thane 400 602

SURESH MATHURE

Science policy

The viewpoint on 'The Scientific Policy Resolution' (October 1983) was thought-provoking.

However, some errors have crept in Table 1. Firstly, the world's population was 3.5 billion in 1971 and not 36.32 million. Secondly, in USSR in 1971, there were 71 papers published per million population and not 871.

M42 Greater Kailash II,
New Delhi 110 048

DINESH JAIN

Coming of age

The article "When your baby girl comes of age" (September 1983) by Dr. I. Vijayakar was superb and enlightening.

Apart from physical reasons for contingent cases of the onset of puberty at an early stage among girls, geographical or climatological factors are equally responsible for menstrual precocity. Generally in countries with a tropical climate, girls attain premature womanhood in comparison to those in cold climates. This is also true among teenage boys who get sexual inducement at an early stage of 14 to 16 years.

Also, the onset of puberty among tribal and working girls is usually later than for girls from middle class and aristocratic families. Thus, social conditions, food habits and strenuous physical activities are some of the possible causes of late womanhood.

1st Madhuban
Cuttack Orissa

BHASKAR PARICHHA

VII Indian Congress of college-going scientists

The next annual Congress of the IACGS will be held in the last week of January, 1984 at New Delhi, with the focal theme, 'Science Education'. The Congress programme will also include a short seminar on 'Science and destruction'.

Participation is open to students of post-school and pre-doctoral levels, below 25 years of age and the areas covered include pure, applied and social sciences. Papers/project reports, etc for selection may be sent to the President, IACGS before 10th January, 1984.

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Instrumentation Centre
University of Delhi,
Delhi 110 007

SANJAY KUMAR

All red eyes are not conjunctivitis

IF YOU think all inflamed red eyes are due to coniunctivitis, you may be wrong. Further, all conjunctivitis is not due to a simple cause such as playground dust, chlorine in the water or due to strain after a long drive. One can suffer an inflamed eye due to more damaging eye trouble where a delay in the correct treatment may be disastrous.

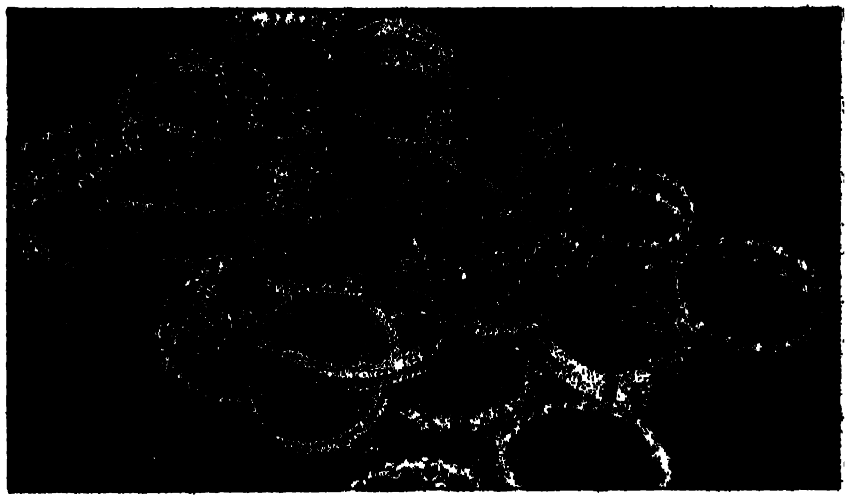
A medical magazine from the UK, *The General Practisioner*, has warned against treating eyes with drops containing broad-spectrum antibiotics combined with powerful steroids. If the patient has herpes in the eye, which the magazine says is not uncommon, the steroids worsen the condition. If used for a long period, the same steroids can cause an increase in eye pressure, glaucoma, which may become irreversible and hence involves a risk of blindness.

How to keep your silver sparkling

HAVE you ever wondered why silver loses its lustre readily but not gold? Recently, researchers at the National Metallurgical Laboratory in Jamshedpur had a good look at this age-old problem.

Silver happens to be highly sensitive to some sulphur compounds in the atmosphere On exposure to sulphur silver reacts to form its sulphide. The impurities in silver may also form other compounds. A thin layer of these compounds formed on the surface is what we call as tarnishing. It is almost like the icing on a cake but much thinner. Clean silver is extremely white since most of the light falling on it is reflected but the tarnished surface reflects much less and looks dull. Foods like onion, mustard and eggs which contain organic sulphur are all known to tarnish silverware.

Is it possible to make silver less sensitive to the atmosphere so that it does not lose its essential quality of lustre? A thin coating of another metal can protect silver—of course the coating has to be so thin as to be almost transparent. By dipping silver in what



Silverware when wrapped in specially made papers and foams retains its lustre

are known as inhibitive solutions, its surface can also be rendered passive. Another method used for the same purpose makes use of an electrochemical reaction.

The most practical way of protecting silver is to wrap it in specially made papers and foams. Just as the gas mask provides protection by adsorbing harmful gases, these papers and foams too retain the corrosive gases and prevent them from reacting with silver.

Baby's face is a mirror

CAN the newborns imitate others' behaviour? The belief so far was that

they cannot. But now tests on 74 newborns at Miami's Jackson Memorial Hospital in the US reveal that day-old infants can recognise and imitate facial expressions. These include the smiles, frowns or surprised looks of researchers.

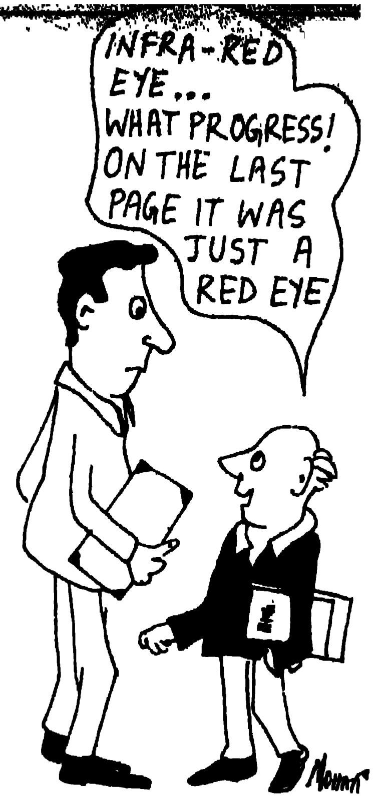
Child psychologist Tiffany M. Field who conducted the tests says the results indicate that infants under three months do have the visual acuity to recognise facial features beyond contrasts of light and shadow Field found newborn babies "pokerfaced" to "extremely responsive" She plans to follow her subjects up to the age of five to discover what these traits portend

Marine animal group discovered

A NEW phylum (major grouping) in the animal kingdom has been discovered and described by Reinhardt Kristensen of the University of Copenhagen, Denmark,(*Journal of Zoological Systematics and Evolution*, 21, 163) It is only the third time a new phylum has been discovered this century

The existence of the new phylum was first predicted by Robert Higgins in 1961. In 1974, he found an organism which should have confirmed his theory but he failed at the time to recognise it as a novel organism.

The organism is a microscopic creature called *Nanaloricus mysticus* which occupies the head of the list of the newly created group. It lives among marine



sand and gravel at depths of ten to hundreds of metres below the sea surface.

New machine preserves fresh food

JEAN Mouty, a French engineer has devised a new machine "Capatainer" to store fresh food for a long time.

The machine is 200 metres long and can wrap agricultural products into cubes of polythene, each having a capacity of 1,200 litres. The cubes are strong, easy to transport and store. They are packed in vacuum and can be piled one on top of another for easy storage. The cubes remain unaffected by bad weather, humidity or sun.

The cost of the capatainer, though steep, is only half that of a classic grain silo. By ensuring long-term protection of 100,000 tonnes of crops per year, Mouty says, the machine pays for itself within six to 18 months.

Birds and fish in trauma

THE *El Nino*, a periodic phenomenon of warm currents, has hit the marine and bird life of Pacific Islands disastrously in recent times In what will certainly go down as a great tragedy in the history of ornithology, almost the entire adult bird population (some 17 million birds) abandoned Christmas Islands leaving behind thousands of nestlings to starve and die. The birds could not put up with the *El Nino*—a complex phenomenon involving changes in wind patterns, salinity, ocean currents and sea levels leading to a rise in water temperature. However, with the gradual disappearance of the *El Nino*, the birds have once again started to inhabit the island.

In the Galapagos Islands, the marine iguanas were badly affected. The unusual conditions led to the disappearance of most of the sea-weed on which the iguanas feed, forcing them to change their feeding patterns with fatal consequences. About 40 per cent of them have died, according to Andrew Lawrie, a zoologist from the University of Cambridge, who is studying the impact of the *El Nino* on iguanas.

The marine iguana

Forgery-proof bank notes

AUSTRALIAN scientists have developed "an almost forgery proof" plastic bank note The note is reported to be more durable than paper money Though it feels like paper, the note is made from a laminate of upto five layers of synthetic polymers (plastics) with a sophisticated optical device embedded below its surface.

The note is made by coating both surfaces of a roll of transparent plastic, between 60 and 80 millionths of a metre thick, with a pigment Once the pigment is dry, it is printed with the note design in the normal way, but a tiny window is left clear, for the antiforging device

The antiforging device, can take one of several forms. For instance, it can be a pouch of heat sensitive liquid crystal that changes colour on contact with body heat. The note could bear a pattern which gives it a cloudy appearance like watered silk, overlapping printed lines appear in this process. They appear to form a changing pattern in black and white, depending on how the note is held Another option is a diffraction grating of parallel printed lines that reflect different colours when viewed from changing angles These devices could either be printed on a note or attached to a role of foil run through a press, with the device on each note. This process could be used to design other security cards including traveller's cheques, credit cards, and personal identification papers.

At the final stage of processing, a coating of clear plastic is laminated on both the sides of each note, to protect the ink and the antiforgery device from damage

Infra-red "eye"

SCIENTISTS from the S. Vavilov Optical Institute in the USSR have developed an infra-red "eye" for use in medicine. The "eye" is a heat remote control device that helps physicians to see on a special screen how a wound heals.

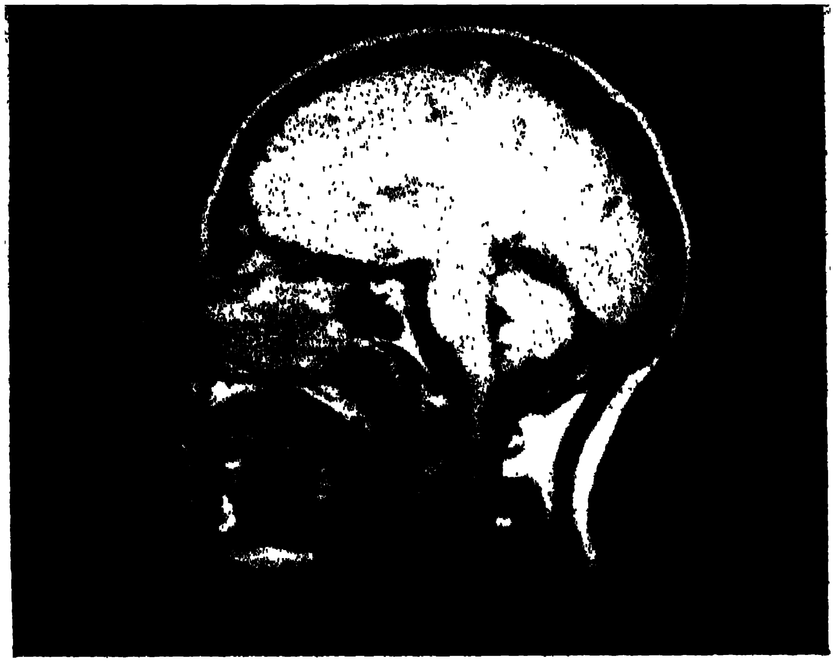
Human organisms are known to emit infra-red radiation which can be transformed into electric signals and viewed as screen images (SCIENCE TODAY, December 1983, p. 17). These images, depending on the skin temperature, indicate any possible pathological changes

The device, in some cases, also helps to diagnose inflammation in organisms at an earlier stage.

Snakes breed in captivity

VISITORS to the snake exhibition organised by the Bombay Natural History Society (BNHS) had a pleasant surprise recently when a Vine Snake gave birth to seven live young snakes This was not all. The striped Keelbacks living in the same pit followed suit by laying a dozen eggs.

P. B. Shekhar and H. K. Divekar, who have conducted several exhibitions for BNHS in the past say that it was the second time such a breeding had occurred during an exhibition. Normally, it is extremely difficult to keep snakes in captivity and rarer still for them to



The skull image produced by the tomograph. The structure of tongue and brain is displayed distinctly

breed, even under strictly controlled conditions. The fact that these snakes had bred in captivity indicated that the artificial environment created for them at the snake exhibition closely resembled their natural environment that they found it conducive to breed.

Satellite link for seafarers

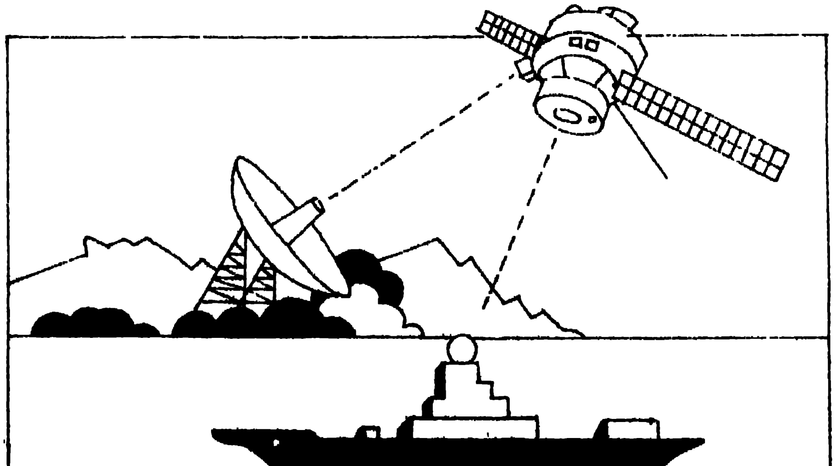
A REVOLUTION has taken place in the communication facilities available to the maritime community A system of three geostationary maritime satellites have made it possible for ships fitted with satellite communication terminals to establish instantaneous link with anybody anywhere in the world.

Until recently ships on the high seas communicated with shore establishments only through high-frequency radio. This medium has several drawbacks—its dependence on the ionosphere, congestion of frequency bands, limited coverage areas and so on. To overcome these disadvantages and to provide reliable and continuous communication link, the International Maritime Satellite Organisation (INMARSAT) with a membership of 40 countries—India being one of them—acquired satellites, which are located in the geo stationary orbit (where the satellite position will be stationary in relation to a particular point on the Earth) over the Pacific, Atlantic and Indian oceans, respectively.

The INMARSAT system provides telex, telephone, facsimile and slow-speed data service. INMARSAT has not only revolutionised sea communication, it has also opened new dimensions in the safety of seafarers. Around 2,000 ships have so far been fitted with satellite ship terminals and a number of earth stations have been set up in all the three ocean regions

India plans to have its own earth station in the next three years. Of the 300 Indian ships, two belonging to the National Institute of Oceanography, Goa, have so far installed terminals and the Shipping Corporation of India has plans to fit its new ships with the terminals

The satellite picks up the message transmitted by the ship and beams it to the coast earth station



Substitute for X-ray?

NUCLEAR magnetic resonance (NMR) tomography is a new kind of imaging method used in medicine During the examination, the patient is placed in a magnetic field. Radio waves of selected frequencies excite the hydrogen atoms in the body and induce them to produce return signals These very weak signals are measured and converted into medical slice images by a computer. Field strength and field homogeneity are decisive for the quality of these images Very high strength magnetic fields are not only essential for the highest image quality and short measuring times, but also for phosphorus spectroscopy, for example, in investigating metabolism. At present, these high magnetic field strengths can only be generated economically by super conducting magnets.

Super conducting magnets are based on the principle that electric conductors of specific materials (for example, niobium-titanium) lose their electrical resistance completely at extremely low temperatures. A super-conducting magnet contains coils of the material which is cooled down to −269°C by liquid helium After installation of the unit, the current in the coils is set flowing by an external supply and when the magnetic strength has build up no further current is required. The flow continues and maintains a constant magnetic field. Cooling is done by means of liquid helium which completely surrounds the

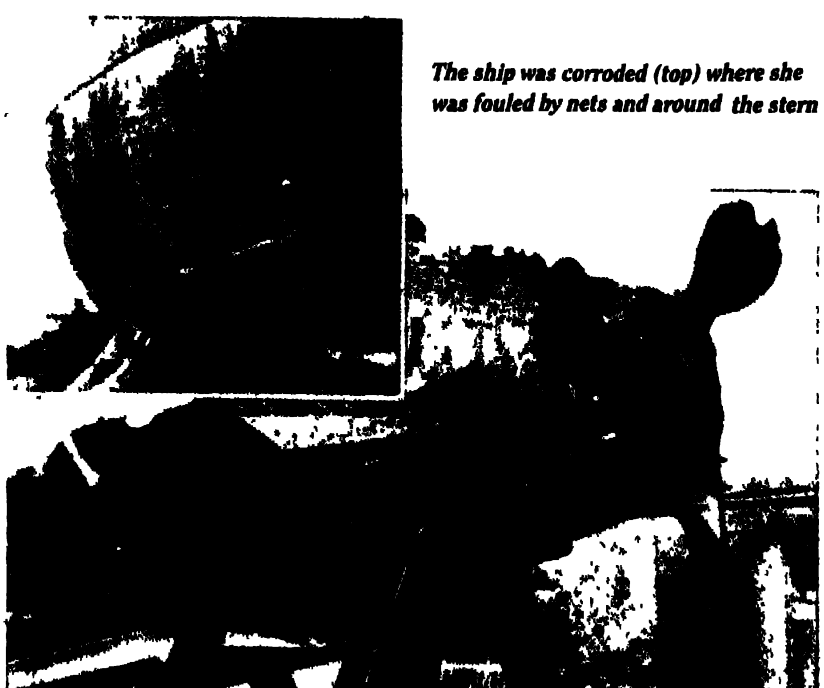
coils. The enclosing container is constructed like a very effective thermos flask. To keep the evaporation losses of the expensive liquid helium as low as possible, it is sheathed by liquid nitrogen (−196°C).

Sunk submarine is rust free

THE main body of a submarine which lay on the seabed for more than half a century has been found completely rust free. However some parts which had fallen off, were found to have corroded. The submarine called Holland 1 had sunk in the English Channel in 1913 and was recovered recently by the Royal Navy.

The hull of the vessel was made of different metals like steel, iron, lead, brass and bronze and yet it remained uncorroded! In fact, the condition of the submarine was so good that "springs sprang, hinges opened, and moving parts were easily freed". The main petrol engine could still be turned over, and the electric motor of the propeller was in excellent condition.

How did the submarine fight the battle against rust so successfully? According to researchers, the reason is probably the presence of a strong magnetic field in the hull. The vessel, meanwhile, is awaiting a careful examination by experts.



The ship was corroded (top) where she was fouled by nets and around the stern

COURTESY NEW SCIENTIST

Laser can tell the taste of wines

THE LASER is moving onto the domestic field. To test wines!

The qualities of wines, such as taste and aroma exist by virtue of the particle types present in it. So it was thought that a light-scattering experiment might "type" wines for identification.

A differential light-scattering helium-neon laser was used to examine wine samples which were diluted 10:1. The logarithm of the scattered intensity was recorded as a function of the scattering angle. It was found that the smoother and flatter the curve, the better the taste of the wine.

The curve can form a part of the label pasted on the bottle which could identify the wine as to its quality. The buyer will have his choice.

Interstellar grain has no bacteria

FRED HOYLE and Chandra Wickramasinghe, the famous British astronomers, maintain that life originated in space. According to them, life could not have originated on our own planet since the time it takes to produce life is much too long as compared to the time that the Earth has existed.

Is there any experimental evidence to the presence of life in space? Experiments conducted in 1980 had indeed indicated the possibility of this. In such experiments one carefully looks at the infrared radiation which is coming to us, through the interstellar space. The presence of bacteria means the absence of infrared radiation of a typical wavelength. David Allen and Dayal Wickramasinghe had found a wiggle in the infrared absorption spectra which was attributed to absorption by C-H bond, typical of organic molecules.

Recently, more accurate measurements of the infrared absorption spectra have been made with the help of the largest telescope specially built for infrared astronomy (United Kingdom Infrared Telescope). It also has the advantage of being on the highest observatory in the world. Also a new type of spectrometer is used to improve the quality of the spectra.

The new measurements, however, have failed to confirm the earlier findings. The evidence for absorption by C-H

bond is lacking in the new absorption curve. The new data suggests that the earlier wiggle was not real, but was probably caused by noise.

It is interesting to recall that, experiments in Leiden, Holland, earlier, had also failed to confirm bacterial theory. Experiments of a different nature had indicated that chances of bacteria surviving in space was very slim—only one in a thousand would be capable of life after 3,000 years.

But the question remains as to what came to the Earth from space—living organisms or nonliving chemicals?

Light weight metro

A REVOLUTIONARY metro known as "Light Automatic Vehicle" (VAL) was installed recently in Lille, the regional capital of North France. Designed to run automatically, it is the first metro in the world to function without a conductor

The Lille metro is made of small underground trains of 26 metres length with two carriages each of two metres width. The carriages are made of aluminium alloy with plastic covering and weigh only 30 tonnes. Each train carries 124 passengers of which over half can be seated.

The trains are controlled using a computer, an optical control panel, an oral keyboard, 24 television receptors and an efficient communication system.

Cedrus oil—natural fungicide

CEDRUS oil obtained from Deodar is an effective fungitoxicant according to a report in *The Journal of Stored Product Research* of October 1983.

Seeds of two spices, coriander and fennel, were dressed separately with the oil as well as with five synthetic fungicides These were stored under laboratory conditions for 12 months. When mycofloral analysis was made on all the batches, the oil was found to have checked the growth of ten fungi, scoring above all the five synthetic fungicides.

There are no adverse effects on the germination of seeds according to the report. Is Cedrus oil non toxic to humans? It appears so, according to the report, since Ayurvedic medicines make use of the wood of the plant.

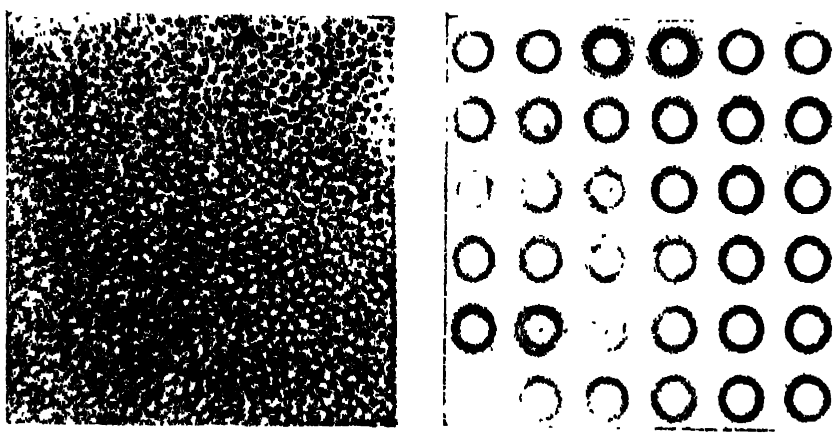
Cancer cells to fight cancer

THERE is an old saying. to remove a thorn employ another thorn. An antidote to a poison is another poison. Scientists at the Cancer Research Institute (CRI) in Bombay, are putting this adage into practice by using a cancer cell in their campaign against cancer.

Leukemia is the dreaded cancer of the blood affecting a large number of patients. It involves malignant transformation and uncontrolled proliferation of the white blood cells (leucocytes). However, the precise type of manifestation it assumes depends upon the type of leucocytes that turn malignant If it is the lymphocytes which are affected, then it gives rise to lymphoid-leukemia while the malignancy of the myeloid series is the root cause of myeloid leukemia. The stage of maturation at which the cells are arrested before undergoing unabated growth also varies. Lymphoid malignancies can also bring about solid cancers of lymphocytes. Unambiguous identification of the cell types causing these cancers has a great bearing upon the choice of treatment.

In recent years, several types of cancers have been shown to possess unique antigens on the cell surface These act like their identity cards. An antibody specifically reacting with this antigen can then distinctly identify them. Such an antibody reactive against myeloid-blasts (extremely premature cells of myeloid series) of a patient suffering from acute myeloid leukemia (AML) has been developed for the first time in India by the CRI scientists.

For this the scientists employed the most sophisticated technology of hybridoma. They took the cells from an AML patient and injected mice with them. the latter recognising the cells as foreign, immediately launched an immune attack against them and generated antibodies. The mouse cells which synthesise these antibodies, however, have a finite life-time. On the other hand, cells from a type of lymphoid cancer called myeloma can grow unhindered. So these two cells were fused to form an immortal hybrid cell—the hybridoma which keeps churning out the antibodies. Of course, the antibodies form a heterogeneous lot and the desired one reacting specifically with the AML antigen has to be sorted out.



ELISA assay (right) and hybridoma clones

The CRI scientists obtained 18 hybridoma clones which were tested with the help of another modern technique with the alluring name of ELISA (enzyme-linked immuno sorbent assay). This yielded 18 clones providing the monoclonal antibody These were then purified and stabilised leaving finally four stable clones. Products of these have been tested for their ability to identify with precision the AML antigen and one of the clones is found to secrete the coveted monoclonal antibody.

These monoclonals have a long way to go before they can be routinely used in clinical practice for diagnosis or therapy. But the first step has been taken.

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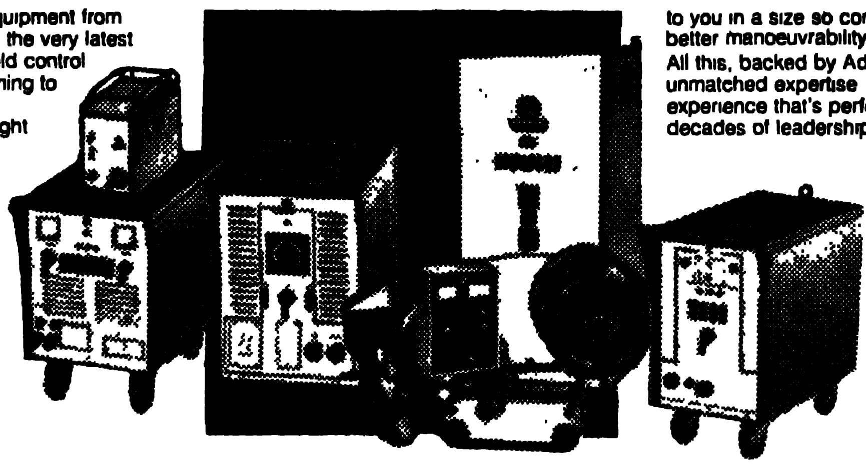

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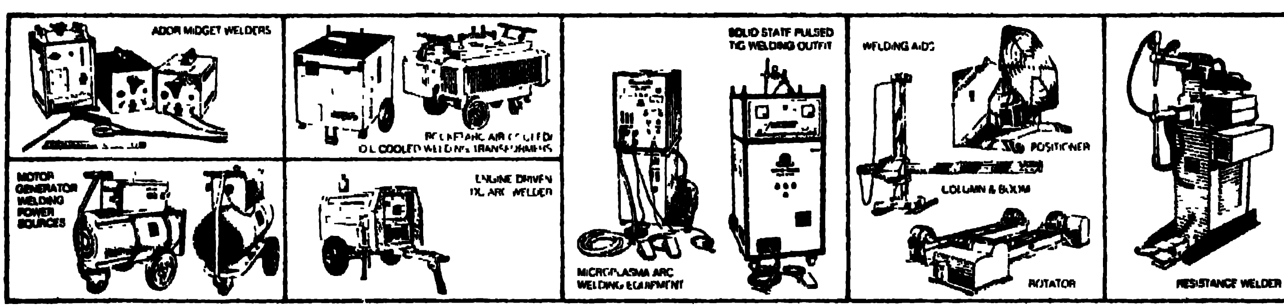

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IS A SCIENTIFIC RENAISSANCE POSSIBLE IN INDIA?

THERE has been a remarkable progress in science and technology during the last 50 years Imagine a world without electricity, telephone, electric lights, motor cars, radio and television and you will realise the contribution made by science in enriching life. It is a matter of history that developments in modern science took place mostly in the European countries. In any case, science did not prosper in India since the death of Harshavardhan in AD 647. There was an unexplained obsession since then to preserve what had been already gained (the invention of making steel, the discovery of zero in algebra, developments in surgery and medicine, etc) and all creative tendencies were discouraged. A similar dark age had also fallen on Europe but it was able to get out of it with a renaissance of science beginning with the invention of the telescope by Galileo in AD 1609.

Why did this happen in Europe and not in India? According to some thinkers, this could happen there because it was preceded by a religious reformation and a subsequent increased orientation of the popular mind towards rationalism. And if India is to make similar progress and take up its rightful place among the industrialised countries for which it has the natural resources and the talent, it has to rely heavily on help from science and technology. But is the atmosphere in India favourable for such a new orientation?

Recently doubts have been expressed about this. Fingers have been pointed at the increasing influence of superstition, ignorance and irrational thought in the country today and the growing number of astrologers, sadhus and godmen who claim among their clientele a large number of educated persons, including scientists. The common man in India spends a considerable portion of his very limited financial resources and time in performing the so called religious rituals which would appear to be meaningless and irrelevant to any thinking person. Remarkably, a large number of these rituals have nothing to do with the basic religion. If he could be persuaded to use his reason and discretion and divert these resources towards more useful channels, would it not be better for him and society too?

In other words, one wishes the common man to develop a more rational attitude towards life and help to usher in a renaissance in India. No doubt, rationalism is a useful attitude in achieving this goal but there are also limitations. Rationalism, by itself, cannot lay down objectives or define ideals. It can provide guidance for realising these objectives in the most effective manner. One can visualise three levels of understanding. On the lowest level, we have the irrational, expressing itself sometimes in the crude forms of superstition and meaningless rituals. It is in this area that one has to look for the roots of the beliefs and faiths of the individual and also, according to some, for fantasy and imagination which represent the source of all creative activities of man. On the higher plane, one has the everyday world where man uses his reason and intelligence to discriminate between and probe into the nature of things. On a still higher plane, we have modern physics where we realise the limitations of knowledge gained from our everyday life.

The existence of man is complex, divided in two parts. In the first, there is literature, the creative arts like music and painting and also philosophy and spiritualism. (One does not want philosophy to lay down laws which science is in a much better position to do. It was a mistake on the part of religion and philosophy to have made these attempts. With its superior instrumentation, science required little time to put them out of count as far as the events in the physical world are concerned. We need philosophy only for asking questions and not for drawing any conclusions.) In the other are included science and technology. Although both these parts have their origin in experiences of daily life, the logic and laws which are valid for one part may not necessarily be valid for the other Investigations in science are mostly guided by reason. The common man thinks that conclusions based on rationalism and science are always the same. But this, however, is not the case

Science has been described as organised commonsense, with an objective rational approach, based strictly on experience and experiment. This view is also not strictly correct In science, one believes that the evidence obtained with our senses is reliable and represents reality. What one tries to do here is to imagine a model to explain an observed event and attempt to correlate as many events as possible in terms of a single model To the scientist, things do not happen of themselves, therefore, he searches to discover the sequence of causally related processes which lead ultimately to the final event observed Science is able to explain how these events take place but not why they take place. Since the scientist's explanation is always in terms of a model, there is no such thing as the ultimate truth. Like the arrow in Zeno's paradox, the scientist always moves a little nearer to the ultimate truth but never quite reaches it at any time. The quality of belief of the scientist is in no way different from that of the religious minded who believes in the existence of a god or in the essential goodness of man. Those who deny the existence of god still have faith in certain moral or ethical principles. Without some sort of belief, and let us say idealism, the formation of human society will be impossible and, what is more important, the individual will not be satisfied. The basic beliefs both in religion and science cannot be justified either by a recourse to reason or to merely logical arguments.

The experience of the individual is, however, limited both

If India is to progress and take up its rightful place among industrialised nations, it has to rely heavily on help from science and technology. But is the atmosphere in India favourable to such a new orientation? Recently doubts have been expressed about this.

in space and time, the actual everyday experience of the ancient man must have been restricted to a region not more than a few hundred kilometres and a period not more than a hundred years. Considering that man can store his experience and pass it on to the next generation, these limits would be considerably extended. Even so, the region about which he actually knows is only an insignificant part of the total universe. Developments in science during the last three hundred years or so again represent only an insignificant part of the total life of the universe. There is no reason to assume that the knowledge that we have gathered in this region over the period of time is representative of the whole universe or represents the final word on the subject.

Let me give some examples. We consider the velocity of light to be a constant and so we have found it to be from experiments over the last several years. According to one theoretical conjecture, however, it should show a variation with time. It will take several years for us to detect this effect if the rate of variation is slow. Again, a hundred years ago we were quite sure that an unsupported body cannot remain suspended in space but must always fall. This statement is valid as far as observations on the Earth are concerned but in the interior of a space ship or in regions of outer space it is simply not true.

Determinism is an important principle in science. Every event has a cause and if the nature of the cause is precisely known, one can make equally precise predictions about it. For instance, in order to explain and correlate the observations of Tycho Brahe on the motions of planets, Newton used his imagination and formulated the law of gravitation. And on the basis of this law, one can calculate the position of any planet not only in the future but also at any time in the past. It is not possible to discover general laws of science by reasoning alone from evidence collected by the senses. The human mind has to use its imagination to guess at the underlying principle which may not be verified by an experiment or a logical justification. One can, however, make some predictions or arrive at certain expectations on the basis of the hypothesis which could be verified by experiment.

A theory which fails to satisfy an indirect test of this type is immediately given up in science, however attractive it may appear to be from the point of view of its logical consistency. Newton's theory failed to explain the Michelson-Morley experiment and was, therefore, replaced by the theory of relativity. (In rationalism, considerable emphasis is laid on logical consistency but there exist no criteria by which the conclusions of any hypothesis could be tested.)

Interestingly, the theory of relativity gave rise to two conclusions which appear to go counter to common sense. A weight of one kg should weigh the same whether it is at rest or is in motion, but the theory of relativity predicts that its mass should increase with its velocity. An actual experiment in the laboratory indeed showed that the mass of an electron goes on increasing as its velocity approaches the velocity of light. Again, according to common sense-cum-rationalism, the rate at which time flows should be the same for all objects or observers all over the universe whereas actual experiment shows that it slows down as the velocity of the body increases and will become zero when it attains the velocity of light.

The example of the solar system is not a good representative of the events that occur in the physical world. For most of the events, the causal relation is not so clearly defined. An example will elucidate this point. The electric bulb which we use in our homes has a limited life. Its average value can be determined by an actual experiment. But this value will not tell us when a particular bulb would go out of action. When it does, there has to be a valid reason why it happened but the parameters involved are so many that it would not be possible to offer a satisfactory explanation.

Modern physics states that many of our conclusions are similarly statistical in nature. One can speak of the probability of an event taking place (the burning out of the bulb in the above example). There is no certainty that it will happen. It has a surprising corollary that one cannot use a theoretical scientific argument to show that a particular event is impossible (for example, the existence of God). A. M. Low has given some examples which show that an indiscriminate use of logical arguments can lead to irrelevant and absurd conclusions.

For most of the events in everyday life, the modifications introduced by modern physics are so insignificant that they could be ignored, and the deterministic conclusions arrived at on the basis of the Newtonian theory are reasonably valid.

As mentioned in the beginning, the existence of man consists of two parts which are not closely linked. It does not therefore follow that a scientist must necessarily be an atheist or that he should show no interest in poetry, music or painting. The aesthetic pleasure one experiences on seeing a beautiful painting or hearing good music is something which is beyond the realm of rationalism or of scientific analysis. With the help of science, we can improve the material quality of existence but all these things together will not make us happy or give us peace of mind. We will not therefore remain satisfied with things in the material world for any length of time. If one sees what is happening in the advanced countries of the West, one would realise the truth of the above statement.

Yet, in order to provide food and the necessities of life to the people there is no alternative to an intensive use of science and technology. Just as rationalism gave rise to a renaissance of science in Europe, the use of science in everyday life cannot fail to have an effect on the way of thinking of the people. The renaissance of science in India is therefore inevitable in view of the economic compulsions.

V. T. Chiplonkar

Dr Chiplonkar is former professor of physics in the Institute of Science Bombay. He now edits the physics section of the Marathi Vishwakosha, published by the Government of Maharashtra.

ORWELL'S NINETEEN EIGHTY

RING out the old and ring in the new" goes the popular saying traditionally used to usher in a new year. 1983 has drawn to a close and 1984 would again be brought in to the accompaniment of the peels of a bell. But those impressed by the Orwellian prophecies may well be asking "For whom the bell tolls?" in the expectation of a reply "The bell tolls for thee, for us, for the human species."

The British author, Eric Arthur Blair, writing under the pseudonym George Orwell accorded a new significance to 1984 so much so that it is not just another year in the Christian era dawning at the completion of the year of our Lord 1983. It is a symbol. It is a newly coined word pregnant with meaning and synonymous with apocalypse for mankind.

Writing in the late '40s about a possible future society, Orwell set it in a then distant future—Nineteen Eighty four creating a hypnotically desolate world. That future date is already with us, if not that dismal nightmarish world. And it is time to take stock of the situation to assess how far the Orwellian forecasts have come true.

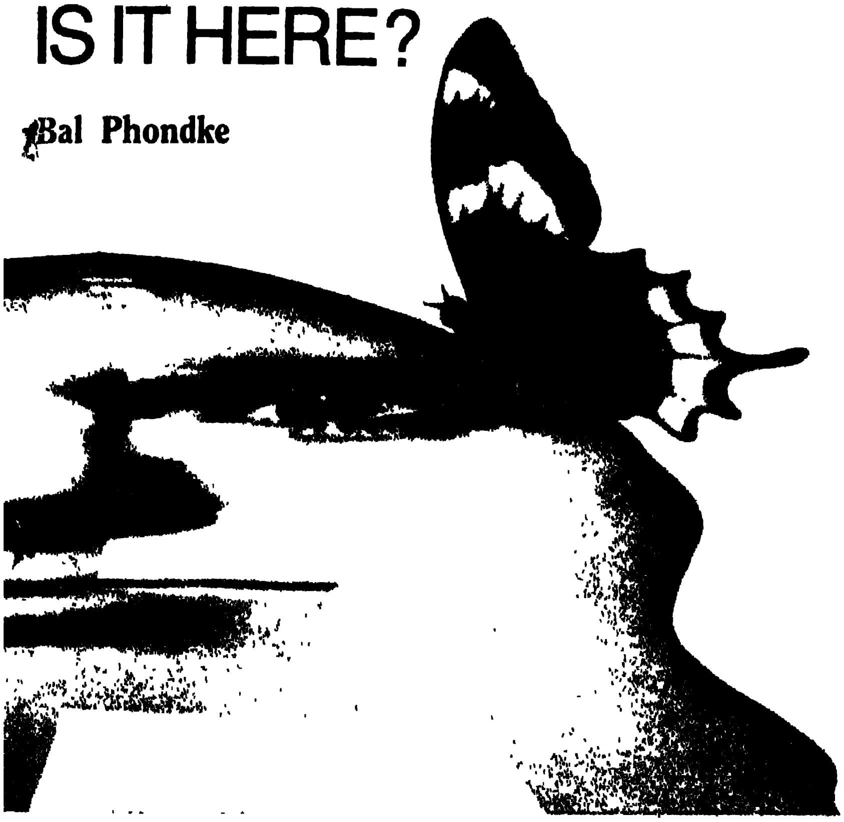
Whether Orwell indeed meant it as a prophecy or a parody is a moot point. For Nineteen Eighty-four has become firmly established as a symbol for a dehumanised society hastily brought in with the aid of scientific and technological development It is debatable whether Orwell was driven by the gruesome destructive force with which nuclear power made its entry in this world. He was certainly influenced by the drawing of the iron curtain across post-war Europe. He was concerned, therefore, about what a totalitarian society could do with such stunning scientific advances to usher in a controlled, uniform, mechanical society totally devoid of all human traits. While the sociological and political aspects of this scenario however important, are not relevant to the present discussion, it is of interest to review the scientific and technological development that has taken place in the last forty years in order to assess where we stand with respect to Orwell's portrayal

Even the first few paragraphs of Orwell's famous novel gives ample evidence of how he thought of science becoming a willing or unwilling ally of the autocratic regime in its attempts at a rigid control of its subjects He described his timid protagonist Winston Smith, a mere cog in the wheel that constitutes the Ministry of Truth being constantly watched by Telescreens set in every wall. If this is not deterrant enough he is continuously admonished that "Big Brother is watching you". Sexual desire is forbidden and procreation is carried out only through artificial insemination. Regimentation is the order of the day with attempts to root out individual variety and to promote uniformity. There are thought police who monitor and control one's thoughts. Thought crime is severely punished. Machines though man-made are used against him to control his behaviour.

Orwell wrote it at a time when machines were increasingly encroaching upon territories until then strictly human preserves. It is not surprising therefore that he was uneasy about how the man-machine relationship would evolve (see pg 23). What provides proof of his perceptive, almost prophetic, vision is that although electronics had made only a hesitant entry into this world he could envision its dominating potential. Television certainly existed then, albeit in a rudimentary form. Vacuum tubes were still the mainstays of electronic circuits which were space consuming. Transistor, in fact, was not introduced by Shockley and Bardeen until 1948 by which time writing of Nineteen Eighty-four was essentially over and Orwell himself was

-FOUR
IS IT HERE?

Bal Phondke



mortally ill Computers were barely introduced but occupied large areas and were very slow People could hardly consider them to be any better than reasonably fast calculators. And yet Orwell must have had some premonition of their power. Although he does not make any direct mention of a computerised world, the scenario vividly depicted by him could now be likened to it albeit with the benefit of retrospection.

How Orwell could foresee procreation only through artificial insemination and more so of thought control is intriguing. For man had then just identified the master molecule of heredity, the deoxyribonucleic acid (DNA). Its structure was not unravelled by Crick and Watson until about five years later. Since then of course a lot of water has flown down the Cam river on the banks of which that momentous event took place. We have come a long way and as we shall see some of the possibilities mentioned by Orwell have become facts But the Biological revolution that one witnesses today was set into motion well after Orwell's death.

It is true that the philosophers and historians of science would perhaps regard this current period more as a time of explosive advance and refinement of information rather than a revolution in biology. Nevertheless, it cannot be denied that this information has the potential to change man's lifestyle for all time to come.

The remarkable advances in molecular biology—a discipline which wasn't yet born when Orwell died—over the past three decades have given man considerable understanding of the basic life processes. The cornerstone of this progress is undoubtedly the technique of gene cloning. The ability to identify with precision the particular gene responsible for endowing a specific trait and to remove that segment of the hereditary material is helping man acquire enormous powers. The range of applications is truly mindboggling. It could certainly be harnessed to relieve man of the several impediments that hold him in check, genetic defects, susceptibilities to ravaging disease, limits to physical and mental prowess, shortages of food and life-saving drugs. But it also promises to help him identify the manner in which the expression of this genetic material is regulated by nature. A major line of research at the moment involves detailed study of the sites in DNA that have specific regulating functions. Once this is done, and that day doesn't seem far away, controlling that regulation modifying it at will would become a distinct possibility. In fact, in 1983 itself, a new type of site, termed "enhancer" has been described which may well turn out to be involved in the tissue-specific and developmental regulation - the process which allows growth to take place at controlled rate and in the intended direction.

Isolation of specific genetic material is no longer an arduous task. The technique is in fact being honed to perfection Scientists have even gone further and introduced in animals genes with a particular function with dramatic results. Production of larger-than-normal mice is a case in point.

Artificial insemination, to which Orwell refers and which was once the chosen technique of the livestock breeders, is finding increasing acceptance by gynaecologists to provide solace to childless couples. Sperm banks have been established and even single women have started shopping around for special genetic traits they would like their offspring to carry! Recently at least two careerist and determined ladies in the US have got themselves impregnated with semen of Nobel laureates. Continued advances would make even this present method of artificial insemination obsolete and

man may eventually be able to do away with sexual reproduction entirely. Although not in human being but with laboratory animals cloning or asexual reproduction has been achieved. This involves taking of an unfertilised egg, denuding it of its nucleus and implanting in it nucleus of a cell from any other organ. Such an egg cell finding itself equipped with the full set of chromosomes or genetic material starts behaving the same way as it would if fertilised in the usual manner. An egg cell from an African cloned frog artificially "fertilised" with the nucleus from an intestinal cell of a tadpole gave rise to a tadpole which was but a xerox copy of the nucleus donor. Such algeny is no longer in the realms of sci-fi.

The analysis of genes, their products, their chemical structure, their isolation, their regulation is but a small part of present-day molecular biology. Attention is being increasingly devoted to unravelling of the mystery and eventual control of organ development and organism behaviour. Orwell's thought control is no more a mere flight of fancy of a talented and perceptive genius. Hyden in Sweden and Ungar in USA have already reported successes with chemical memory transfer. When a broth made out of brain tissues of rats taught specifically to shun darkness which they normally prefer was injected into other rats, the latter also shied away from dark places. Ungar went further and isolated a small protein which he called scotophobin from the Greek words for darkness and fear.

Although these experiments deal with induction of an existent behavioural pattern,given the pace,development of molecular biology opens up the possibility of introducing de novo a desired or conditioned behavioural response. If this is not thought control what is?

One could use such a technique to enhance the extent or speed of learning. But many observers feel that it could be equally or perhaps more gainfully employed to control man's aggressiveness. Using another tack but with the same goal, American physiologist Delgado implanted electrodes in strategic places inside the brain of a bull bred and raised for fierceness. Then with only a small radio transmitter for protection he turned into a scientist-matador and stopped the bull in midcharge. Anthony Burgess has vividly demonstrated in his "Clockwork Orange" how such eradication of aggression can lead to a total loss of even self defence.

Whether the aim is thought control or not, thought process research is increasingly engaging the attention of neurophysiologists and psychiatrists. Richard Wyatt and William Freed of the National Institute of Mental Health in the US have been experimenting—with reasonable success—on brain-tissue transplants. The blood brain barrier created by nature presumably to protect the brain from toxic substances also makes parts of the brain an immunologically previleged site. Thus rejection of these transplants is

averted. The grafted tissue has been shown to grow and thrive. The technique itself is beguilingly simple. All that Freed does is to drill a hole in the skull, push through an electrode to stimulate different parts of the brain in order to locate the required region based on the observed response to stimulation and then inject the graft at the site. Work has already started on primates—the nearest evolutionary relatives of human beings. Homo sapiens per se can't be far behind.


JEANTECOULTRE SWITZERLAND

Orwell's Scientific predictions thus have come true. In fact more than what he foresaw is coming into being. But is nineteen eighty-four here? For these scientific developments are mere instruments according to Orwell. They are double-edged swords.

How man uses them would decide whether we step off a precipice or stride into a brave new world. This fact seems to have been appreciated by man. He appears to be equally concerned and perhaps Orwell's parody has served as a warning signal. There are several signs of this. Despite the unabated and unsurpassed growth of nuclear missiles, Hiroshima and Nagasaki have not been repeated. True, satellites have been used for snooping but they are used more for communication and for reaching out to the universe. The new-found power of molecular biology is being used to increase food production, to make it more nutritive, to overcome the crippling manifestations of genetic diseases, to prepare vaccines for immunisation against ravaging infections. Proponents of brain research plan to use it to provide relief from neuropathies like Parkinsonism or Alzhemeir's disease. And finally there are at least two documents signifying mankind's collective wisdom, and intention to keep the Pandora's box closed. The letter written by a significant number of senior nuclear physicists headed by Albert Einstein to the then President of the US warning against the nuclear weapons and a similar attempt by molecular biologists cautioning against further research in recombinant DNA technology known more popularly as the Asilomar declaration vouch for man's good intentions. One need not therefore despair with Orwell.

1984 has come; it will pass. Nineteen eighty-four, however may not arrive.

An evolving man-machine relationship

Bernard Dixon

DURING a recent visit to New York I noticed, in a Third Avenue store, one of the most intriguing products of modern technology that I had ever seen. It was a carving knife. But it was not a simple knife, made in the traditional form. This was an automatic piece of cutlery, powered electrically and controlled electronically. Alongside the blade was an adjustable guide, and the handle carried several buttons, like those on a pocket calculator, together with an LED (light-emitting diode) display to indicate the speed of blade and thickness of slice selected by the user. This, then, was the silicon-chip version of one of mankind's most venerable tools. But it was constructed in a form which would totally baffle an Indian from the northwest Pacific coast, a member of the Hanunoo in the Philippines, or anyone else drawn from one of the world's more primitive societies. Indeed, such was its complexity that it would baffle many citizens of the so-called developed West too.

Relationship with machines evolving

I propose to take that carving knife as a symbol of what I shall be discussing in this article: the way in which our rapidly evolving relationship with machines, tools and apparatus is simul-

taneously enhancing and impoverishing our lives. Largely as a result of the burgeoning of microelectronics, man-machine interactions are altering in an unprecedented fashion, bringing new capacities, comforts and pleasures while at the same time threatening to obliterate important aspects of our understanding of the world about us. Those of us privileged to live in the midst of this revolution are, of course, more conscious of such changes than are the peoples of the Third World. But because the basics of microtechnology are so astonishingly cheap (think of the dramatic fall in the prices of transistor radios, digital watches and pocket calculators over the past decade) there is no doubt that these developments will have similar effects on us all. It would be as well, therefore, to pause to consider some of the merits and demerits of recent, contemporary and future change. I plan to do so by way of a number of key examples.

Early radio receiver comprehensible

First, let us consider radio. As recently cently as thirty years ago it was possible to construct a simple wireless set (so-called because it had succeeded the telephone) in a few hours. The components, which were fixed with screws to an elementary wooden chassis, consisted of a detector (a crystal or valve), a coil of wire, a variable condenser and a pair of headphones—with perhaps a few extra items like resistors and a transformer in the case of a rather more advanced receiver—and batteries were required to operate the valve. Using a circuit diagram, the various elements were linked together with wire, switched on, and it was invariably found that the hook-up operated perfectly.

There were two consequences of this arrangement. First, anyone making his own set—and the hobby was very widespread indeed—could hardly fail to understand some basic principles of radio reception. The crystal or valve detected the signal and the coil and condenser determined the desired wavelength from those available from the transmitters. True, it was not possible actually to observe electrons arising from the red-hot filament (the cathode) and passing on to the anode inside the glass valve. But the fact that he was dealing with a tangible object, like a light bulb, helped even the most non-technical person to grasp what was happening. Similarly, it was possible literally to see the movable vanes of the condenser passing between the fixed vanes and thereby changing its capacitance. People who played with radio in this way often felt that the whole thing was something of a miracle. But because their equipment was so simple and solid, the miracle was comprehensible.

The second consequence was that repairing a defective wireless was child's play. The trouble was sure to be something elementary. The battery may have run down. There might be a loose connection. Or one individual component may have failed. Either way, the task of locating and correcting the fault was straightforward. And this applied even to the more complex, more powerful, receivers purchased commercially. The problem here, when a set went wrong, was usually the demise of a valve—which could easily be pulled out of its holder and replaced.

Radio changed beyond recognition

Today, radio has changed beyond recognition. Reception has improved enormously, particularly since the supplementation of AM (amplitude modulated) by FM (frequency modulated) transmission. The quality of sound is incomparable with that of thirty years ago, and interference has been virtually abolished. The range of stations has increased hugely too. And all this has been associated with a fall, not an increase, in the price of equipment. Against the inflationary trend of recent years, which has seen the cost of most consumer goods rising, high-quality radio sets have plummeted in price.

But these very welcome developments have also had a negative effect. They have been made possible by successive stages of miniaturization—first by the advent of transistors, which began to replace valves during the 1950s, then the appearance of printed circuits, and most recently the emergence of silicon chips and large-scale integrated circuits. The end result is that the inside of a modern radio, whether a pocket receiver or domestic version, is unrecognisible from that of a similar set three decades ago. No longer are individual components connected with wire. Whole circuit, are made as integrated operating units; yet even those collective components are staggeringly small. Again, there are two consequences of this step forward. People no longer build their own receivers. And they no longer repair them. So, while the principles of radio—principles such as detection, tuning, rectification and amplification—remain unchanged, their modern physical form has taken them beyond the familiarity of all but the experts—electronic engineers. The rest of us, in terms of scientific literacy, have lost out.

Pocket calculators...

Now let us turn to perhaps the most obvious of all incursions of modern microtechnology into private life: the personal and domestic computer. Indeed, let's go back one step first and recapitulate the arguments that were triggered off by the appearance of the earliest pocket calculators in the late 1960s. Teachers and educationalists argued ferociously at that time against handing such gadgetry over to school pupils, on the grounds that they would

destroy numeracy and make youngsters into illiterates unable to manipulate figures or develop a 'feel' for mathematical manoeuvres. Against this viewpoint, other voices pleaded that silicon-chip calculators would actually encourage people to understand numbers, quantities and mathematical functions.

A decade later, it is quite clear that the enthusiasts were correct. The use of calculators—assuming it is intelligent rather than blind use—does help children to familiarize themselves with the nature of arithmetical and algebraic processes. The very simplicity of a pocket keyboard and the speed with which it can be employed to repeat, check and cross-check calculations makes it into a powerful tool for the promotion of numeracy, not its destruction. Of course, the counter-arguments discussed above in relation to radio apply here too. Counting on an abacus is a minor step forward from counting on the fingers of your hands; it is still 'obvious' and tangible. Move from there to a slide rule and you introduce a more sophisticated principle into calculation, but the equipment remains accessible and understandable. Progress further, to the point at which you can do trigonometry on a minuscule scrap of silicon, and you place the operation of the apparatus outside the range of genuine familiarity. At the same time, the facility provided by this microelectronic marvel is such that it can heighten beyond measure our grasp and use of mathematics. Financial budgeting, for example, has been transformed, because people now find themselves routinely doing sums they would never have found time for or even considered doing before. Figures brandished by politicians and lobbyists can be checked out in an instant. And so on. Far from curbing numeracy, the pocket calculator has created it: the person who is innumerate now is the person who cannot use one.

... to personal computer

Hence to the personal and domestic computer. Even in 1983, it is possible

HORST ANTES FRG

to purchase a genuine computer, on which to learn programing, for under $100, and the current trend towards greater storage and handling capacity at a lower price will doubtless continue. This means that the vast majority of people can afford such machines, and large numbers are indeed buying them to help them manage their affairs. As Western countries (with France in the lead) move towards being on-line societies, those prospects will take on a further dimension. With home terminals linked to banks, shops, public utilities and other organisations it will be possible for extensive areas of our affairs to be determined by computer software.

For many people, such a prospect will appear frightening—again because of its remoteness. Indeed, the electronic transfer of funds is certainly more remote than, say, the transfer of coins to the office in one of those old-fashioned shops equipped with an overhead system of cash canisters propelled along wires. One you can see, the other you cannot. What has happened, as with the carving knife and countless other examples, is a move from a simple mechanical system to an electronic one. And this has all occurred very quickly, bringing in train what in the United States is called 'high tech anxiety', an unease caused by the suspicion that events that ought to be under our influence have gone beyond our grasp or understanding.

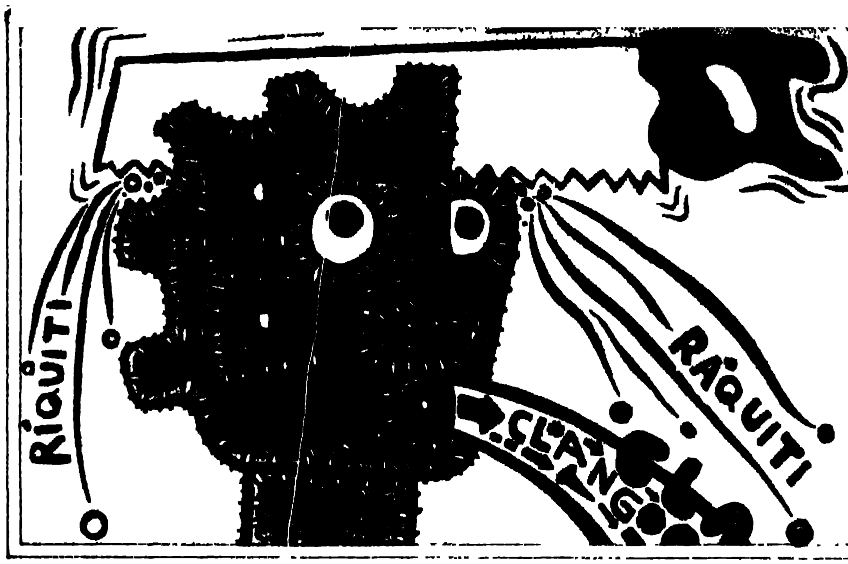
The answer here, though, as with pocket calculators, is not to reject change but to consider how new technology will be used. It is you, after all, who will program the computer to time the purchase of your new car. It is you who will select the criteria which (together with real-time about second-hand car values, the rate of increase in new vehicle prices, and other relevant data) lead to the final decision. And that decision, while still in your hands, will represent much more careful, detailed consideration than would have been possible without microelectronic assistance. The balance of benefits is quite obvious.

Music-making considered

My third example is a leisure activity: music-making. Of all man's traditional pursuits, constructing and playing musical instruments is one of the most elemental. Stretch a skin over a wooden frame and you have a drum. Punch some finger holes in a reed or cane and you have a simple fife. Fix some pieces of gut between pegs on a board and you have an elementary guitar or other strumming device. Stroke the strings with horsehair and you progress towards the violin family. As early man devised these archetypal instruments, he refined his understanding of rhythm, pitch and melody. Indeed, the best way even today to comprehend the principles of music is to discover for yourself the physical laws governing a simple scale. Tapping a series of glasses containing different quantities of liquid is one approach. Another is to find the points on a stretched string which have to be held down in order to generate the notes of a diatonic or other scale.

Production of the silicon-chip

Now bring yourself up to date and take a look in the window of a typical music shop. There, in addition to conventional guitars and pianos, you will find a different family of instruments altogether. Most, but not all, have a keyboard like that of the piano and all are products of the age of the silicon-chip. They range from electronic organs, which differ in only one sense from a reed organ (they generate



ALFREDO SOSABRAVO CUBA

sound electronically rather than via pipes), to sophisticated automatic synthesisers which can yield the most grandiose music in the hands of the most musically untalented players. The very latest such device, allowing non-musicians to make music instantly, is now to be found in bars and restaurants in Japan. It is a computerised amplifier which can transform the tuneless wailing of a stone-deaf person into something enviably musical—adjusting pitch and tone accordingly. We have come a long way from the fife and drum.

Microelectronics—a spur to creativity

It is of course difficult to perceive the sort of satisfaction that can be derived from 'playing' a fully automatic, programed synthesiser, or 'singing' into a piece of equipment which then manufactures an acceptable voice in place of your own. So let us leave such excesses, and return to our main theme by considering what effect silicon-chip-based instruments have had on people's musical knowledge and aptitudes. Again, as with mathematics teachers at the time when pocket calculators appeared, music tutors were the first to complain about home organs with 'automatic play' facilities when they came on to the market during the early 1970s. They felt that the incorporation into a traditional keyboard instrument of novelties such as rhythm generation, chord selection, and arpeggio 'fill-ins' would make young learners lazy and stifle natural talents.

In fact, precisely the reverse has been made possible. Used to help, rather than replace, a person's own rhythmic, harmonic or digital skills, a modern microelectronic organ offers considerable advantages on the learning curve, someone in their third or fourth year of studying the piano, for example, can turn to such an instrument and pick up relatively painlessly the construction of major, minor dominant seventh and diminished chords. The silicon-chip replaces hours of tiresome work on manuscript paper Similarly, a dance-band musician who is having difficulty in imprinting the rhumba, mambo or bossanova rhythm on his or her cerebral cortex can drive enormous benefit by following these rhythmic patterns on the machine. And for player or composer, the availability of a wide range of synthesized sounds (whether simulated versions of other instruments such as the trumpet and cello, or entirely new sounds) is of inestimable value. For both novices and experts, the resources of a modern electronic keyboard can be both an aid to performance and a spur to creativity. It depends entirely on how the machine is used.

Closely paralleling these changes in the musical world is the replacement of manual and electric typewriters by their electronic equivalent: the word processor. There are many benefits to be had from the use of word processors: rapid correction of mistakes, storage of many thousands of words, which can be printed out as hard copy at any time; and easy editing; such that paragraphs can be switched at the touch of a key, words can be altered throughout a lengthy text which can be reshaped quickly Writers who have become thoroughly familiar with such instruments invariably find that their work has been lightened and their output improved. But here too there is another side to the picture. Word processors now coming on to the market do very much more than provide users with facilities to make life easier. They incorporate features described as creative—for example, word banks which, in the manner of Roget's Thesaurus, disgorge comprehensive lists of synonyms the writer can consult when stuck for precisely the right noun, verb or adjective Another facility is the automatic correction of grammer and syntax and spelling

As my fifth example, I will take an incipient development that concerns scientists as a profession: the movement towards the electronic journal. For some years now, learned societies and international organisations have been increasingly concerned about the print, paper and other costs incurred in scholarly publishing. There have been many suggestions—such as issuing periodicals only on microfilm, microfiche, or as individual 'reprints'—which would help to save money. But these have mostly been resisted on the grounds that a conventional journal, with its full, detailed discussions of experiments and their significance, is one of the keys to scientific intercourse. It is through journals, together with conferences, that the dynamic, critical nature of science finds its fullest expression.

Today, with world recession aggravating the diseconomies of publishing even further, possible salvation is at hand in the form of microelectronics, We can now conceive of a journal that does not exist in a hard, paper form. The idea is as follows. A research group would use a word processor to prepare its latest paper. When the text is completed and checked, it would be sent on-line (probably through the telephone system) to the editorial offices of the journal concerned. There, the editor would scan the paper on a VDU (visual-display unit) and either return it on-line to the authors for revision or forward it electronically to a referee. The referee in turn would read the paper on a screen, key in any comments or criticisms, and return the material on-line (or on a disc through the post) to the editorial office. Eventually, the paper would be accepted and would go into the next issue of the

journal. But none of the material would ever be set in type. It would be available, in a data bank, for interested researchers to access and consult. Their reading load for this and other journals would, in fact, be greatly eased. Instead of visiting the library to thumb through periodicals every week, they would simply key into a computer lists of important topics. The computer would do the rest, alerting researchers to the latest publications in their areas of concern and delivering the contents on screen at the touch of a button.

An arrangement of this sort would be amazingly efficient. It would save money. And it might well hasten particular developments by opening up avenues of inquiry through highly selective literature searches. Science would undoubtedly benefit. On the other hand, there would be drawbacks. Such a system might, for example, heighten specialisation, by continually focussing the attention of electronic journal users on their own narrow discipline. Keying in your requirements on a computer terminal is categorically different from curling up in an armchair to browse through the latest batch of journals. So the chances of noticing, by serendipity, an interesting paper in an adjacent field would be virtually nil. Cross-fertilisation, which is so important to the lifeblood of science, could well be impaired. On a different level, too, international intercourse might be adversely affected—particularly as it concerns Third World scientists.

Let us conclude by returning to our initial question: Will the efflorescence of microelectronics, as well as enhancing our lives, also impoverish them? Certainly, no aspect of life is likely to go untouched by the revolution now in progress, from the serious (the learned journal) to the trivial (the carving knife), from leisure (music) to work (word processing). And in every case one can discern the two sides of the balance sheet. While the astronomical resourcefulness of computers in medical diagnosis has already been established, for example, there are anxieties about what this may mean for the human skills which have long been major components of the physician's craft. Similarly the fully computerized farm of the near future (already, individual cows are being fitted with mini-computers) could eclipse the farmer's traditional affinity with his stock, his crops and the cycles of nature.

The most disquieting aspect of the silicon-chip revolution, though, is not its distancing us from nature—even before the Industrial Revolution, man was trying to do that—but its distancing us from understanding.

Fortunately, as we have seen, that is not an inescapable response. Indeed, in many fields, such as music and domestic computers, the technology is such as to facilitate learning and extend understanding. The real test is how to use it. And that poses a further question: Is education today helping pupils to grasp the full benefits of the microelectronic revolution while at the same time compensating for the loss of those familiar skills which really have gone for ever? □

Bernard Dixon is the former Editor of New Scientist. *Reproduced from* Impact of Society on Science; no. 2, 1983 © UNESCO 1983.

AN ODD MAN OUT

LIKE Sam Clement (Mark Twain), Eric Blair is a writer more renowned by his *nom de plume*, George Orwell. For all his enormous posthumous fame, throughout his life Orwell was the odd man out—a man of maverick views, a bohemian who disliked bohemianism, a tramp who intended to settle in life, a socialist who ever despised communism and a democrat who felt that capitalism in effect *was facism*. Orwell was equally opposed to the Right and to the so-called orthodox Left.

Eric Arthur Blair was born in India in 1903. He was an indifferent scholar at Eton. Since he could not afford to go to a university without a scholarship, he opted for the Indian Imperial Police Service* in Burma. Troubled by bad health and bad luck, Blair resigned his commission and returned to England an embittered man five years later. He became by turns, a dish-washer in a Paris hotel, a volunteer in the Spanish Civil War, a pamphleteer, a broadcaster on B.B.C. during the war years and a journalist and writer.

Orwell's first wife, Eileen O'shaughnessy, died in 1945, leaving behind their 10-month-old adopted son Orwell married Sonia Brownell in 1949, just three months before his death by pulmonary tuberculosis at 46

A compulsive urge to express his opinions made him write. "Writing a book is a horrible, exhausting struggle, like a long bout of some painful illness", he said in *Why I write* (1947) "One would never undertake such a thing if one were not driven on by some demon whom one can neither resist nor understand." It was only after the Spanish Civil War that Orwell became a regular journalist. Among his best known literary works are *Down and Out in Paris and London* (1933), *Burmese Days* (1934), *The Road to Wigan Pier* (1937), *Animal Farm* (1945), and *Nineteen Eighty-Four* (1949)

Nineteen Eighty Four presented a dystopia in which the State has achieved near-complete thought control It is a dreadful vision. It might have turned out to be a far cry of its author. But that Orwell saw this dreadful vision so clearly in the late 40s is no less commendable. The questions, whether, why and how Orwell went wrong will be argued vehemently and discussed and will be soon forgotten but the catch-phrases such as "All animals are equal, but some are more equal" (the wittiest remark in the 20th century?) and "The Big Brother is watching" or "War is peace: Freedom is slavery: Ignorance is strength" will continue to haunt the minds of political and social dissenters for many years to come

Aroon Tikekar

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BLACKOUTS: why do they occur?


FIRST there was chaos and then, as the night descended, total darkness. For nearly three hours on that 13 July evening last year, the entire industrial State of Maharashtra went without power, grinding everything to a halt. There was a tangled mass of people and vehicles on the roads of Bombay. Heavy rains added to the misery. Though the power supply came back by about eight o'clock in the night, it was well past midnight when the traffic jam cleared up.

A series of events led to this blackout. Earlier in the day, at 2.30 p.m., in a considerably loaded power system, a generator at Koradi tripped and 200 MW of power was lost. It probably came back on line again, but at 3.15 p.m., the State Electricity Board cut itself from Gujarat by opening out the line between Tarapur and Borivli (which connects the Tarapur Atomic Power Station to the state grid) to prevent Gujarat from drawing excess power from the Maharashtra grid. About the same time, the Hubli-Belgaum line, connecting the State to Karnataka, tripped for a few minutes. Between 3 and 4 p.m. the frequency showed no signs of improving beyond 48.5 Hz. At 4.21 p.m. the Kolhapur-Belgaum line tripped, pushing the system frequency down to 47.5 Hz when most of the generating sets in Maharashtra went off the line and the state was plunged into complete darkness.

The gravest power failure in the world occurred in North America on 9 November 1965. A back-up relay protecting one of the five lines feeding power from a US hydroelectric power station (Beck No. 2) to the northern part of Canadian United States Eastern (CANUSE) Inter-connection operated and caused the circuit-breakers at Beck to open the unfaulted line. The power flow on the disconnected line shifted to the remaining four lines, each of which then became loaded beyond the critical level at which its back-up protective relay was set to function. Thus the four remaining lines tripped out in cascade in 2.7 seconds. Within four seconds after the initial tripout at the Beck Station, most of the CANUSE area east of Michigan was broken into segments (islands). The islands which had excess generation experienced overfrequency and those with excess load experienced underfrequency conditions before generators in all the areas ultimately tripped due to large deviations in frequency. People were trapped in the underground transit system and in tall buildings. To thirty million people, the only source of alternative power that night was the Full Moon.

Although the two incidents are not comparable, they raise several important questions.

Are there any deficiencies in the overall planning of co-ordination of power grids which would trigger another incident that will cascade (cause sequential tripouts) into a massive failure of the system?

In our sophisticated power technology which is producing supersize generators and increasingly complex interconnections, have we in some instances neglected to provide adequate controls and back-up equipment that can assist in an emergency situation?

As one possible approach, have our state electricity boards planned adequately for scheduled load shedding by automatic and manual controls in an emergency situation in which underfrequency develops? Is the load shedding dictated by technical considerations?

Have we in the engineering profession become so self-satisfied by our technological and scientific achievements that we have lost sight of the potential dangers lurking in emergency or unexpected situations?

To know and appreciate the reasons for power failures, which are becoming too common, one must first look at how a power system works and how it is generally controlled. That might help bring to the surface some glaring departures from the standard technical guidelines for such operations and the consequences of such departures.

Electrical power in India is generated at an alternating voltage whose frequency is 50 Hz (Hz. means cycles per second); in some countries like the USA, the standard frequency is 60 Hz. The standard frequency could be set at 50 Hz or 60 Hz, but once fixed, this frequency must be maintained constant; this is to ensure that the system components like turbines, generators, motors and other electrical appliances which are designed to function at this

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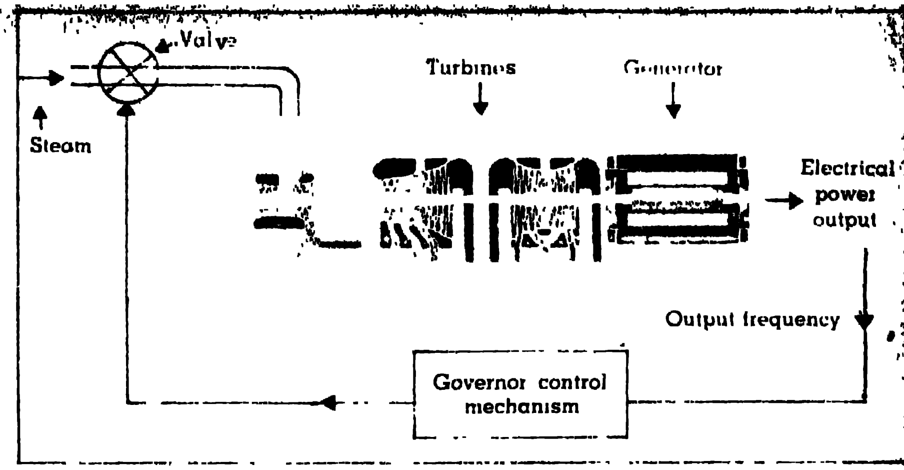
frequency do not malfunction.

The frequency at which electrical power is generated depends on the speed with which the generators rotate. The total electrical demand on a system is met by the mechanical power supplied to these generators by the turbines (steam or hydraulic). Whenever the demand (load, in the parlance of electrical engineers) increases, steam or water input to the turbines is automatically increased by the governor-control mechanisms (see figure). At a constant frequency, the turbines and generators rotate at a constant speed.

Since there is a limit to which steam supply to a turbine can be increased, there is also a limit to which electricity generation can be increased. But the demand for power may at times exceed even this limit. Under such conditions, the speed of the generator and the frequency go down and settle at a lower value, resulting in *underfrequency operation* of the system. (This is because the excess demand for power is partially met by drawing on the kinetic energy of the rotating system, which lowers its speed and consequently the frequency.) Continuous underfrequency operation therefore means continuous shortage of electric power.



The general control scheme of a power generating system.

In a way, this is similar to how supply and demand governs the price level in a free market, though, with a little difference. When the supply of a commodity matches the demand, the price level remains constant; when the demand is more than the supply, the price goes up. In a power system, similarly, when the demand matches the supply or generation, the frequency remains constant; but when the demand goes up over supply, the frequency drops.

If the electric power generated in a system meets the demand satisfactorily, then the system is working in the *normal* state. If an event like tripping of a line or a generator is likely to result in a state indicating overloading of system components and/or a net shortage of generation, then it is called the *alert* state. And if the demand cannot be matched by generation, at the normal frequency, then it is called the *emergency* state. This shortage of generation necessarily results in underfrequency operation if no load is shed, that is, if power supply is not disconnected to a section of the consumers so that the demand matches supply again.

What are the consequences of such underfrequency operation? Continuous underfrequency operation affects the performance of various equipment connected to the system. For instance, an induction motor driving a water pump for irrigation would draw larger cur-

It could happen again...

AN efficient, economic and reliable power supply is essential to every segment of our economy and it is in the vital interest of everyone to assist in the constructive and remedial action that need to be taken to attain this supply. Finding scapegoats is not the answer nor are recriminations in order. Instead, those entrusted with the development of science and technology, including the electrical engineering profession in particular, must take up the challenge of providing a satisfactory solution to the problem of power failures.

The failures may be due to faults in generating systems or in instruments which continuously monitor power supply to various areas in the system. Or it may be due to excessive overloads on the system which may then sink faster than the rate at which load can be shed. In short, it is either *equipment failure* or *service failure.*

There are well-established procedures to overcome the technical problems associated with both the types of failures. Knowing all the parameters of operation and the control actions (one of them being automatic load-shedding when there is excessive demand) to be exercised, the natural question is, are they being practised in reality? There are reasons to believe that they are not. Then is there any interference by vested interests and/or political forces? This introspection among all those who are directly or indirectly associated with the management of the supply systems will go a long way in finding a solution to this problem.

A starting point could be technical meetings, conferences and publications which will provide an open forum for professional discussions of the problems. One, unfortunately, notices in our country the total absence of such exchanges. It is worthwhile to mention that the preliminary hearings on the Northeast blackout which occurred on 9 November 1965 were held on 20 November, and the comprehensive preliminary report by the Federal Power Commission was submitted to the US President on 6 December, 1965 (just 27 days after the incident) and was available from the United States Government Printing Office. And within a short time after there was a final report, giving a complete analysis and several recommendations.

All these reports were published and were available to anyone who was interested in the subject. In contrast, even six months after the blackout in Maharashtra, one does not know whether a report has been submitted, though a committee was appointed a month after the blackout.

It is therefore the moral duty of the power companies, whether private or public, to submit detailed reports of any major blackouts for open discussion among professionals. This will help in the ultimate analysis of the problem and remedial measures to prevent the repetition of such occurrences.

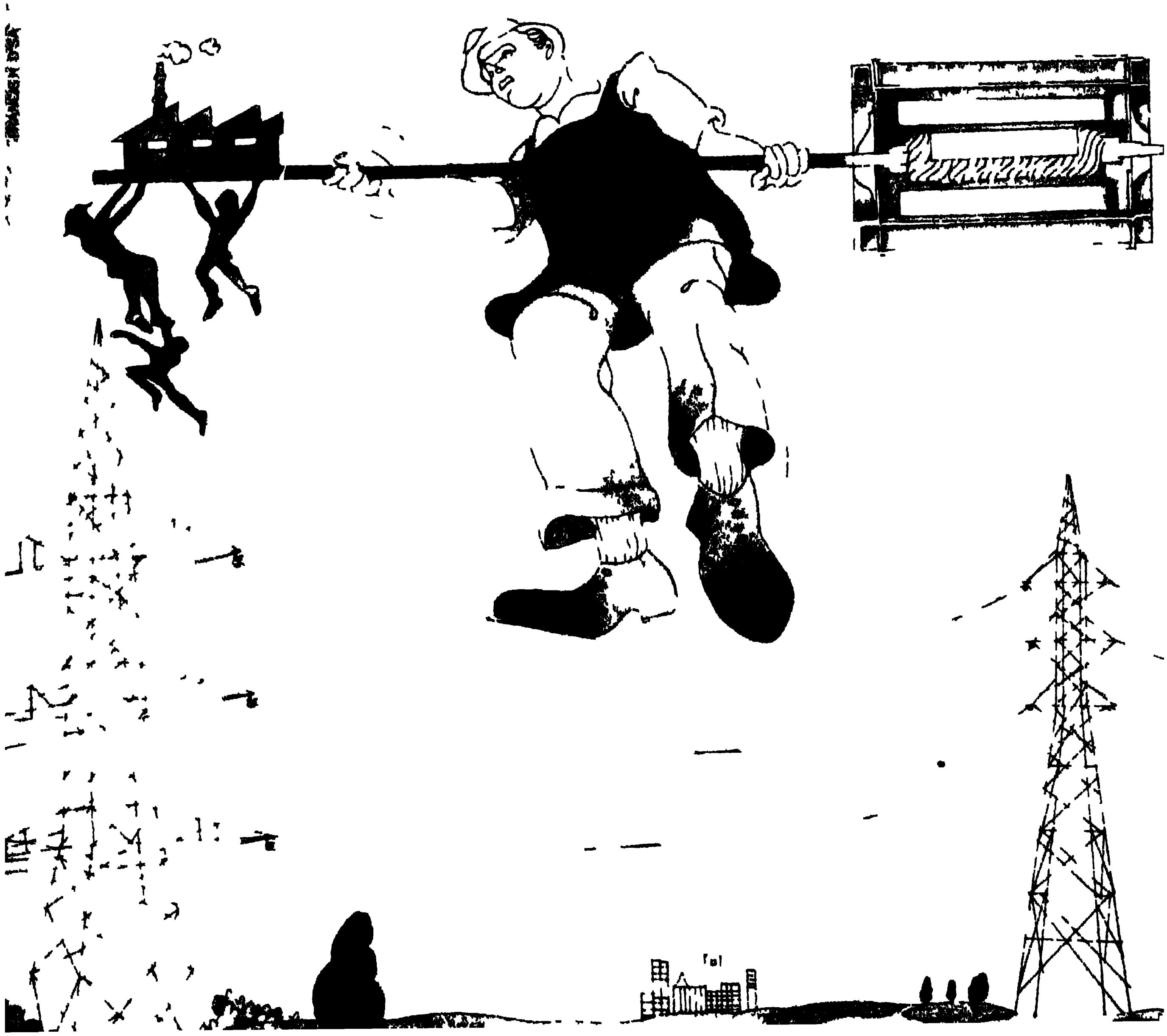
Having come to grips with engineering challenges, there would still remain the formidable task of convincing the vested interests and political forces! Who will bell the cat?

Despite the serious consequences it has, why does our system operate most of the time at a subnormal frequency, usually 49 Hz? The reasons seem to be far from technical

rents at reduced frequency which lowers its efficiency, for the same power output, more electrical energy would be consumed and the electricity bill would go up Domestic appliances using induction motor drives like refrigerators and air conditioners are similarly affected Electric clocks connected to the system would run slow, which is one of the reasons why electric clocks have generally gone out of the market As for domestic appliances which do not use induction motor drives, like lamps, irons, geysers and heaters, they are not affected much

Not so obvious to the common man, but well known to power engineers is the damage that underfrequency operation can cause to generating machinery, particularly steam turbines At off-normal frequencies the turbine blades are subjected to shock and caused to vibrate, the greater the departure from the normal frequency, the greater the vibrations And the vibrations could reduce the turbine life Research into this aspect was conducted by General Electric in the US in the mid-1960s following the Northeast power failure The conclusions of this study gave the time limits for off-normal frequency operations of steam turbines (see figure) Though some engineers have expressed doubts about the exact value of these limits there is unanimity that frequency should be restored to normal in the shortest possible time

Continuous underfrequency operation also greatly hampers the man



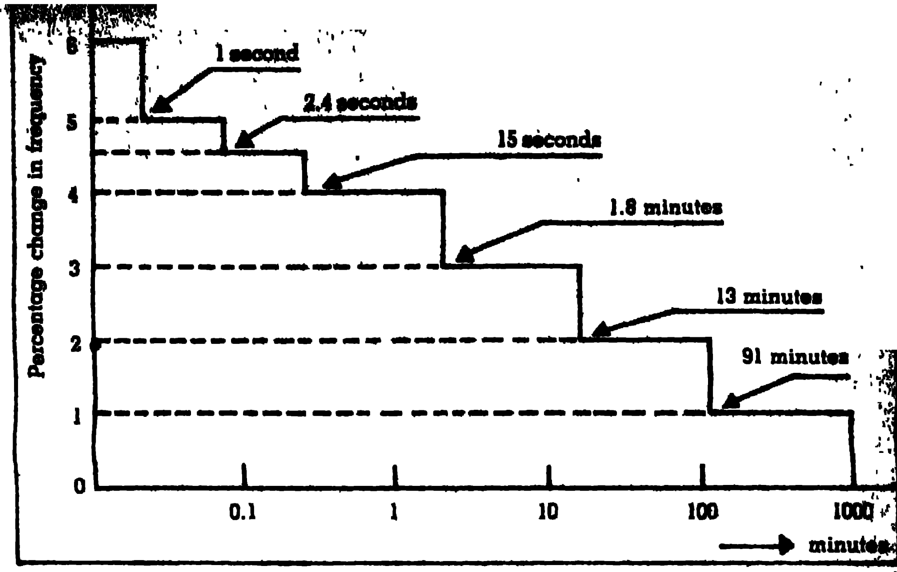
oeuvring capability of system engineers in emergency conditions. A generator is set to trip automatically when the frequency drops to 47.5 Hz (5 per cent deviation from the normal of 50 Hz). Now consider a system which constantly works at 49 Hz. In case of severe disturbances, the frequency would reach 47.5 Hz much faster than when it operates at 50 Hz. This means that the time available for corrective action is drastically reduced and chances of a generator trip increase. Though a generator trip is not uncommon, and may generally be tolerated under normal operating conditions, tripping under emergency conditions gives a devastating blow to the system because it results in less availability of power precisely when one wants more and more of it.

Despite these serious consequences, why is it that our system operates most of the time at subnormal frequency, usually at 49 Hz? There appear to be considerations which are far from technical.

Manoeuvring under emergency conditions

In an emergency, there are generally two ways of bringing the system back to normal. the first is to shed load and second, to boost generation if sufficient spinning reserve capacity is available (spinning reserve is that power which can be injected into the system within 10 minutes and is obtained from generators which are kept running and are usually supplying very little power but are ready to pick up generation when demanded). There are standard guidelines given by power utilities and organisations for load-shedding. For example, in the US, automatic load-shedding relays are set to disconnect supply when the frequency drops 1.5 per cent below the normal. What is to be the setting of these relays when the system normally (!) operates at 2 per cent below normal?

The dilemma here is whether or not one should readjust the relay settings. And, if yes, to what extent? If the short-term approach of adjusting the relay settings goes very far, it may



Operating limits for steam turbines (worked out by General Electric) at various states of frequency deviation from the normal. At a frequency deviation of one per cent from the normal value, the system could be allowed to operate for only 91 minutes, for two per cent, 13 minutes, and so on.

upset the entire coordination of the underfrequency settings in the system. For example, if the generator relay is readjusted to trip at a lower frequency, say 46 Hz, then the underfrequency setting of all other generators and relays in the system will have to be readjusted, which is a serious problem. Also, if the rate of frequency decline is very fast, then a crucial generator may trip before the automatic load-shedding relay disconnects the load! Is this what happened on 13 July, 1983 in Maharashtra? That the Koradi generating unit tripped at 2.50 p.m. has been reported, but was it the cause of the final collapse at 4.21 p.m.? Or was there any further loss of generation elsewhere?

Boosting the spinning reserve comes only next to load-shedding in saving a sinking system although it could be effective in the initial stages of declining frequency. There are, however, some problems. Boosting generation in the shortest possible time would require close and efficient coordination of boiler controls and the turbine-governor-control mechanism. There would also be a limit on the power ramping rate (the rate at which generation can be increased) which would again depend on the particulars of boilers and turbines. Also, if the generation is increased at a rate faster than recommended in an anxious moment, there is every likelihood of the generator being tripped due to some other upsets in the boiler or turbine at a critical point. This will defeat the very purpose for which the spinning reserve is provided. Because of these factors, the effectiveness of spinning reserve in bringing a collapsing system to normal working condition is rather limited.

System restoration

System restoration starts when the system has failed completely or partially and has come to some steady state. More often, it is the "brownout" rather than the blackout, from which restoration starts. How soon the system can be brought back to normal depends upon the generation sources (thermal or hydro), transmission facilities, availability of auxiliary power sources, the nature of disturbance which caused the failure, the availability of qualified personnel for unit and station start-up and the system load requirements. Thermal power stations take a longer time for start-up. Hydroelectric stations, on the other hand, have a distinct advantage over thermal stations in that they can usually be started without auxiliary power other than the emergency battery requirement for light and control circuits. By placing gas turbine generating units at strategic urban locations, power supply can be restored at least for vital services almost immediately following a widespread system power failure. The complete restoration plan involves adjusting generation to demand, resynchronising the islands which had formed, restoring loads which were shed, getting generating units or plants back on line, re-establishing scheduled interchanges and then scheduling repair of any

(Continued on page 69)

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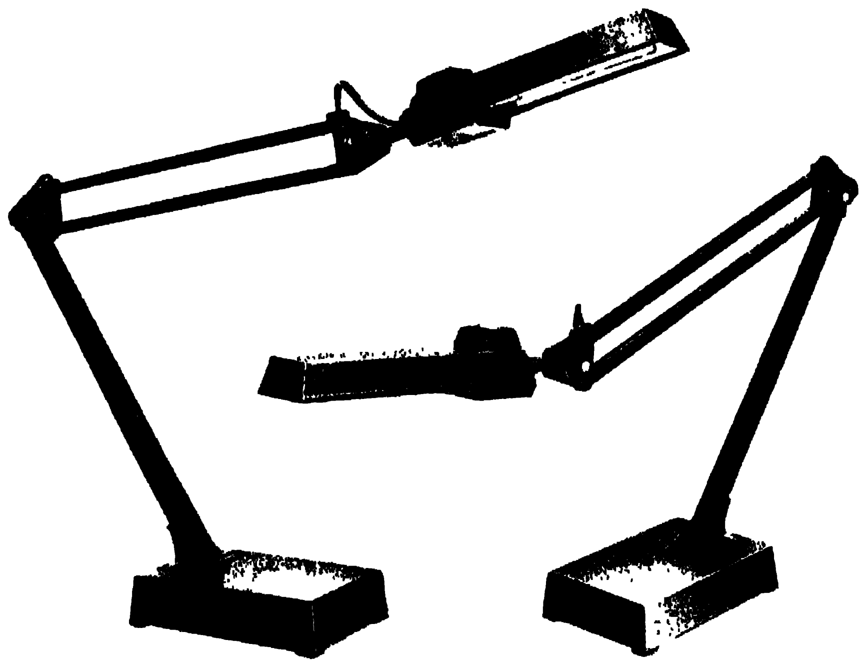

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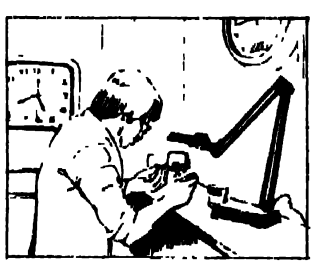

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COOKING SCIENTIFICALLY

COOKS were the world's first scientists and they are still among the most skilful even if unwittingly so Ever since prehistoric times, cooks have used sound scientific principles, even if only dimly or incompletely understanding them, in preparing and processing food Recipes, most of them handed down through generations, represent the culmination of much trial and error, and many experiments in the kitchen Cooks have always been good at experimentation and keen and minute in their observation of the results, two vital aspects of all scientific work

Indeed modern science s debt to cooking is greater than might be imagined The first laboratories were kitchens, the first research benches kitchen tables, the first scientific equipment the stoves, cauldrons, jars, bottles, pans bowls knives ladles and ovens of many a long forgotten kitchen From the earliest alchemist to the youthful, budding scientist of today, the kitchen has always exerted a tremendous fascination, and the mysterious processes of heating soaking baking grinding grating, chopping, mixing and even brewing first began in the kitchen long before laboratories were invented

Look at some of the ways the cook acts as an unwitting scientist Heating is of course the commonest cooking operation Most foods are easily digested if heat is used to change the protein and starch in them into forms which are more readily broken down by the body The natural enzymes of the digestive juices can more effectively reach their "target" molecules, when the outer cell walls and membranes have been broken down or burst open by the heat of cooking

Tips for vegetarians

Colour plays an important role in vegetable cooking Cooked peas, for example, may be an appetising shade of green or biliously coloured, depending on how they were cooked Chlorophyll, a green pigment in plant tissues, gives peas and other green vegetables their characteristic colour Chemically, the chlorophyll molecule has a 'head comprising of a magnesium atom enclosed in a large, flat ring-shaped structure and a tail The presence of this metal atom gives chlorophyll its bright green colour In the presence of natural acids and heat, the chlorophyll molecule is attacked The magnesium atom is substituted with hydrogen atoms causing the colour to fade

Thus peas and other green vegetables like *palak*, beans, and cabbage should be boiled or cooked in an uncovered pan in a minimal quantity of water or without it After one or two minutes of boiling the heat should be lowered and the vegetables allowed to cook till they are tender This ensures that they do not lose their colour

Carrots too change colour on cooking The pigment carotene confers a characteristic orange yellow colour To prevent discolouration, carrots should be cooked as little as possible Other fruits and vegetables whose colours fade on cooking include red pumpkin sweet potatoes and oranges

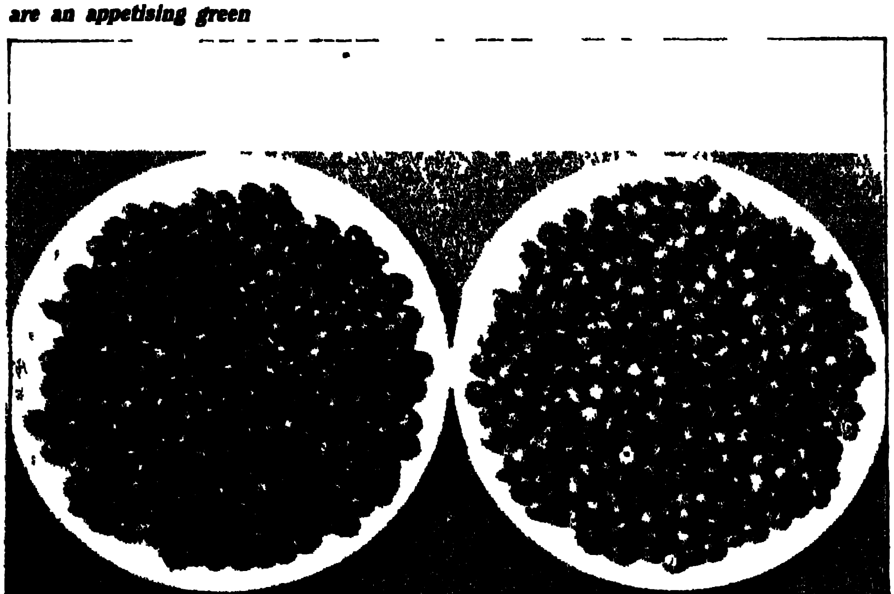
Carrots lose their brilliant orange colouration on cooking and turn a dull yellow

When a cook puts peeled potatoes in water before boiling them or sprinkles lemon juice over apples and bananas in a fresh fruit salad he prevents the natural oxidation process that causes unsightly browning Alternatively, apples and bananas can be cut with a knife dipped in a salt water solution

Cooks unwittingly rely on basic scientific phenomena to tickle the palate and delight the eye

The traditional squeeze of lemon juice on boiled rice keeps it white and fluffy and prevents unattractive yellowing This, in fact is a sound chemical treatment of an acid-sensitive pigment in the rice that turns yellow if it become too alkaline Lemon juice added to sauces retards spoilage due to bacterial growth because of its citric acid content

Peas cooked in vinegar appear a drab olive colour, while those cooked in baking soda are an appetising green



With respect to minerals and vitamins the news is bad. Cooking depletes or destroys these nutrients. Bicarbonate of soda, is often added to green vegetables to improve their colour and to items like white grams (*Cicer arietum—chana*), for fast cooking. It creates an alkaline solution that accelerates loss of vitamin C. The use of large amounts of water in cooking, is the worst of all, as water dissolves or leaches essential minerals and vitamins which are left behind in the pot.

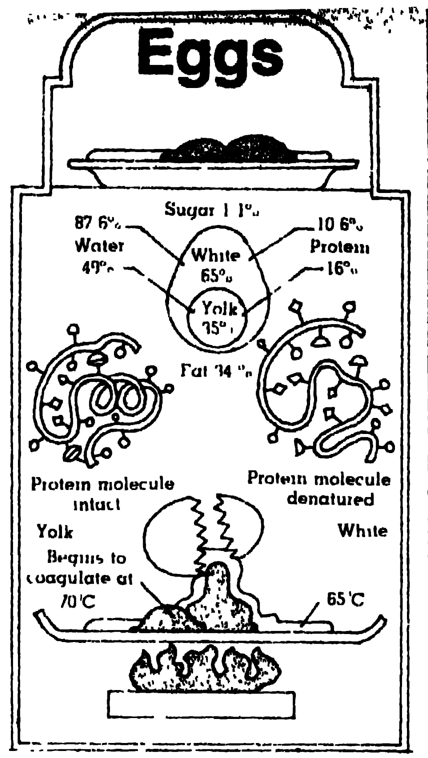
Chinese cooks have always used fermented soyabean sauce to enhance the natural flavours of cooked food. Modern culinary science now gives both the food manufacturer and the housewife the vital chemical ingredient of this sauce, monosodium glutamate or *ajinomoto* as it is popularly called, for exactly the same purpose. Volatile flavour components are released by heating it with vegetables, like carrots, cabbage and other foods.

Fats, an important nutrient, are generally easy to digest and are little affected by normal cooking. Overcooking reduces their nutritive value, while prolonged overcooking makes them inedible. By far the most important result of cooking fats is on the other foods cooking with them, as fats add essential nutrients. The Indian and Chinese practice of cooking vegetables and other foods in groundnut oil or soyabean oil, for example, adds vitamin E and linoleic acid to the finished dish Frying an egg in butter or margarine also adds a whole cluster of nutrients, including vitamins A, D, and E and triglycerides. Cooking with fats adds a high proportion of calories to food.

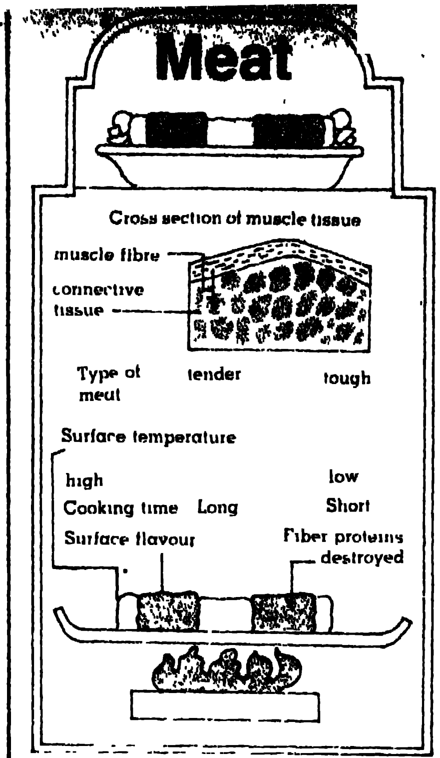
Savouries

The cook has also always been an unwitting physicist, too, conjuring up various surface phenomena essential to certain culinary results For instance, when puff - pastry or *parothas* are baked or cooked, pockets of steam are generated between the layers of flour and fat, causing the food-item to swell This expanded form, especially for the pastry, is later preserved when the heat of the oven sets the flour proteins, so that correct baking times and temperatures are purely chemical conditions that the cook must regulate.

Similarly, the formation of a skin on the surface of heated custards, sauces and similar foods is prevented by putting a blob of butter on them This melts and so prevents the interaction of the liquid with the air to form a cooling crust of skin or an "apron". On the other hand,



The white and yolk of eggs differ in basic composition and nature of their proteins



Tender and tough meats also differ in composition

when the cook whips up the white of an egg to make meringue, this same reaction of surface-setting is deliberately encouraged. To ensure this, all fat must be absent, and since egg yolk is nearly one-third fat, it has to be most carefully separated from the white, which alone is used.

Whipping of egg whites for meringues, souffles and cakes is related to changes in protein structure. Egg whites normally exist in the presence of water. By whipping air into the system, the proteins get stretched and unfold to form a rigid, foamy structure. [see SCIENCE TODAY, June 1983, page 39.]

Egg yolk is generally the emulsifier in preparations like mayonnaise, ice cream and milk-jelly. Its fat content comprises phospholipids and cholesterol which have excellent emulsifying properties.

The protein content of the egg contributes the property of coagulation and so is used to bind mince when making meat balls or cutlets. For vegetarians, the boundary effect is obtained by wrapping the cutlets and other items to be fried like *pakodas* in *besan* (gram flour) puree. Heat-induced coagulation causes changes in the proteins. In raw eggs, the protein molecules exist as long coiled, roughly spherical chains held together by weak bonds. Heating changes this. It causes the weak bonds to break and the protein unfolds and forms a rigid gel. This process is called denaturation. White proteins coagulate at 62°C to 65°C while yolk proteins coagulate at 70°C. Coagulation is an irreversible process so when making custards, sauces or other dishes which require only thickening and not complete coagulation of eggs, the heat should be slow and regulated.

All cooks also make use of some man-made chemicals in their work, like baking powder for instance. Baking powder is sodium bicarbonate mixed with acid phosphates and tartrates. It releases carbon dioxide gas inside flour products and so "raises" or lightens them. Man-made chemicals also greatly enhance the flavours of certain savoury dishes.

Meats

It has long been known through practical experience that tender meat from young animals needs little cooking, but tougher varieties require long and careful cooking to make them palatable. This is because tender meats contain little connective tissue and the others much more. Long cooking is required to break them down or render them into gelatine that makes the meat tender to chew. However, the same effect can be achieved without cooking too; in hamburgers and *kheema* for instance, beefsteak or slices of meat are broken up by chopping and can be eaten raw as steak tartare.

Gastronomists even classify the flavour of cooked meats into two categories: 'base notes' and 'species notes'. Base notes in effect, are characteristic of all meats and are similar in character. They are derived from heat-induced changes in the sugars and amino acids present in meats. Species notes are those subtle flavours that distinguish, say, chicken from mutton.

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BIGRADE PROPERTY OF MAGIC SQUARES

AMONG the interesting properties of magic squares, the bigrade property was shown by D. R. Kaprekar in SCIENCE TODAY, March 1981, where he maintained that this property does not hold for magic squares of order higher than three. However, 4×4 magic squares also have this property.

A fourth order magic square formed by the numbers 1 to 16 is shown in Fig. 1. The magic constant of this square is 34, that is, the numbers in each row, each column and each of the two main diagonals add up to 34. The sums of the squares of the numbers in the two outer rows are,

$$1^2+14^2+15^2+4^2=438$$
$$13^2+2^2+3^2+16^2=438$$

and the sums for the inner rows are

$$12^2+7^2+6^2+9^2=310$$
$$8^2+11^2+10^2+5^2=310$$

sides of the dotted square (12, 14, 3 and 5; 15, 9, 8 and 2) show the following properties:

$$12+14+3+5=15+9+8+2=34$$
$$12^2+14^2+3^2+5^2=15^2+9^2+8^2+2^2=374=34\times 11$$
$$12^3+14^3+3^3+5^3=15^3+9^3+8^3+2^3=4624=34\times 136$$

Note that the sums of the squares and the cubes of the numbers are multiples of 34 which is the magic constant of 4×4 square.

The rows and the columns of the 4×4 magic square can be shuffled to give the magic square of Fig. 3. The sums of the squares, as well as of the cubes, of the numbers on the main diagonals of this square are equal

$$12^2+3^2+14^2+5^2=8^2+15^2+2^2+9^2=374$$
$$12^3+3^3+14^3+5^3=8^3+15^3+2^3+9^3=4624$$

$$31^2+9^2+17^2+7^2=25^2+15^2+23^2+1^2=1380$$
$$3^2+21^2+13^2+27^2=5^2+19^2+11^2+29^2=1348$$

Another 4×4 magic square can be obtained from the digits 1, 6, 8 and 9. This magic square (see Fig. 5) has a magic constant 264 and has some curious properties. These properties bear resemblance with the well-known bigrade property of magic squares.

The sums of the squares of the numbers in the first row and the second column (1R=2C) are the same:

$$96^2+11^2+89^2+68^2=11^2+69^2+86^2+98^2=21882$$

Similarly for the second row and the first column (2R=1C) the sums are again equal:

$$88^2+69^2+91^2+16^2=96^2+88^2+61^2+19^2=21042$$

The sums for the third row and fourth column (3R=4C) and for the fourth row

1	14	15	4
12	7	6	9
8	11	10	5
13	2	3	16

Fig 1

1	14	15	4
12	7	6	9
8	11	10	5
13	2	3	16

Fig. 2

12	6	7	9
13	3	2	16
1	15	14	4
8	10	11	5

Fig. 3

31	3	5	25
9	21	19	15
17	13	11	23
7	27	29	1

Fig. 4

96	11	89	68
88	69	91	16
61	86	18	99
19	98	66	81

Fig. 5

The same is true of the columns. Each outer column's numbers when squared and added give the sum 378,

$$1^2+12^2+8^2+13^2=378$$
$$4^2+9^2+5^2+16^2=378$$

Each inner column's squared number add up to 370

$$14^2+7^2+11^2+2^2=370$$
$$15^2+6^2+10^2+3^2=370.$$

The 4×4 magic square under consideration has some additional interesting properties. Inside this square draw a smaller square as shown by the broken lines (Fig. 2). The numbers appearing on the opposite

Now, we show the bigrade property of a fourth order magic square formed by using odd numbers from 1 to 31. This magic square (Fig. 4) has a magic constant of 64.

For the two outer rows the sums of the squares of the numbers are,

$$31^2+3^2+5^2+25^2=1620$$
$$7^2+27^2+29^2+1^2=1620$$

The sums for the inner rows are

$$9^2+21^2+19^2+15^2=1108$$
$$17^2+13^2+11^2+23^2=1108$$

For the outer columns and the inner columns the sums are respectively 1380 and 1348.

and third column (4R=3C) are again the same: $61^2+86^2+18^2+99^2=68^2+16^2+99^2+81^2=21242$

$$19^2+98^2+66^2+81^2=89^2+91^2+18^2+66^2=20882$$

Thus there exist some relations between the sums of the numbers in the neighbouring rows and columns. This property can be called amicable property of magic squares. When the above square is turned upside down it still has the same magic sonstant.

P. K. Mukherjee

Dr. Mukherjee is lecturer in Physics at Deshbandu College, New Delhi.

PLAY WITH DIGITS

THE digits, to begin with 8 and 9 can be played with to give products of interesting properties. We have:

$$9\times 8=72$$
$$79\times 8=632$$

Let us denote the multiples of 8 as M_x and the result as R_x in the xth stage. Generally, M_x can be obtained by placing the extreme left digit of $R_{(x-1)}$, on the left of $M_{(x-1)}$, and R_x can be obtained by placing, x consecutive digits starting with 2, and (8−x) in unit, 10th, 100th... position respectively. And R_x will always be of (x+1) digits. We have:

9×8=	72	(i)	(7=8−1)
79×8=	632	(ii)	(6=8−2)
679×8=	5432	(iii)	(5=8−3)
5679×8=	45432	(iv)	(4=8−4)
45679×8=	365432	(v)	(3=8−5)
345679×8=	2765432	(vi)	(2=8−6)
2345679×8=	18765432	(vii)	(1=8−7)
12345679×8=	098765432	(viii)	(0=8−8)

In the 3rd stage, x=3, Hence,3 consecutive digits, namely 2, 3, 4 and 8−3=5 make the series auto-consecutive. In the 8th stage x=8, that is, 8−8=0. Therefore R_x is not of (8+1)=9 digits but of 8 digits.

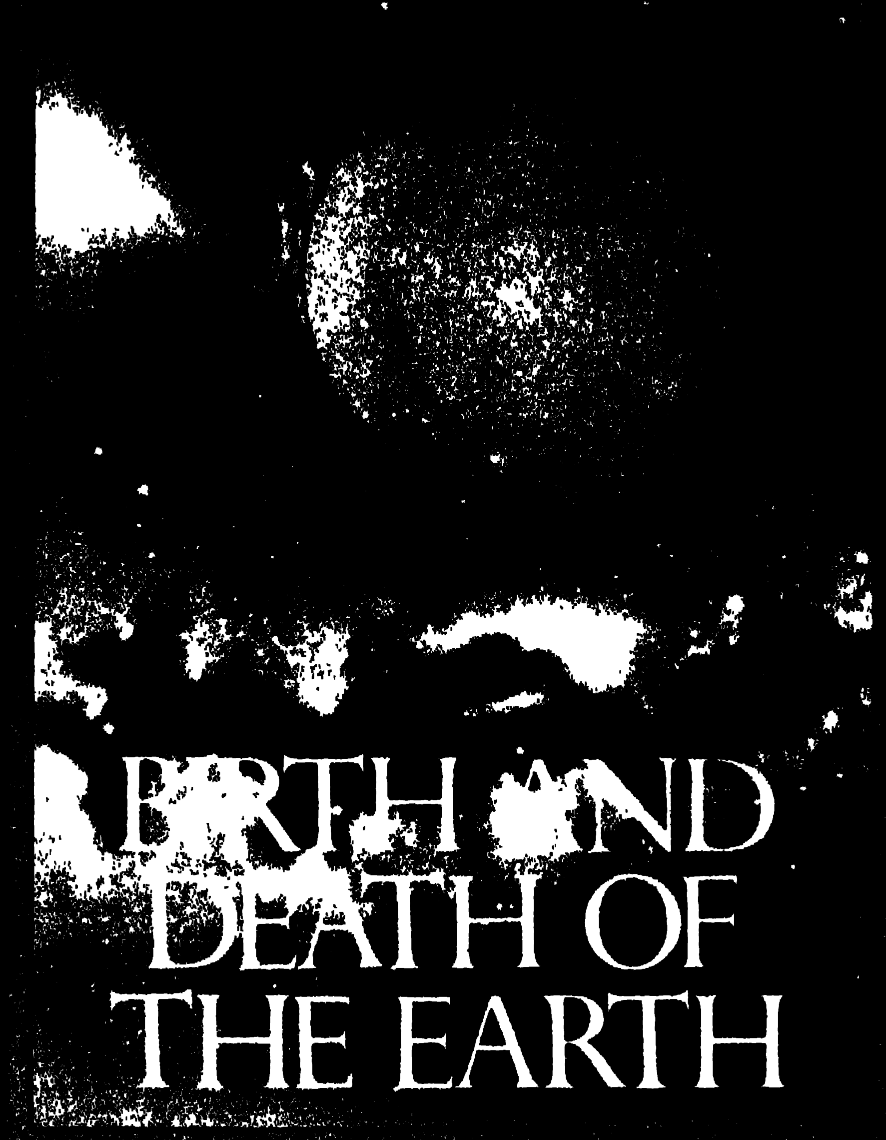
It is interesting to note that the extreme left digits of M_x (excluding 1st stage) and R_x are consecutive digits. And in 8th stage if 1 is taken away from M_x and [(9−1)=8] is removed from R_x, the numbers are symmetric to each other, that is, they are reversed in order.

Sajal Chakraborty

Mr. Chakraborty is a . . res Officer at Central Coalfields Ltd, Dhenkanol, Orissa.

BIRTH AND DEATH OF THE EARTH

W[illegible] Carl Sagan [illegible]



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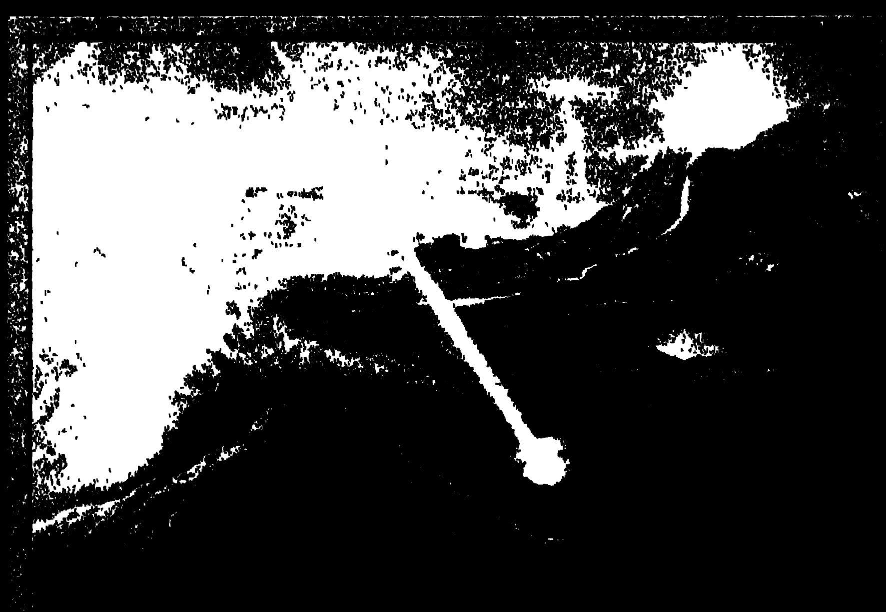

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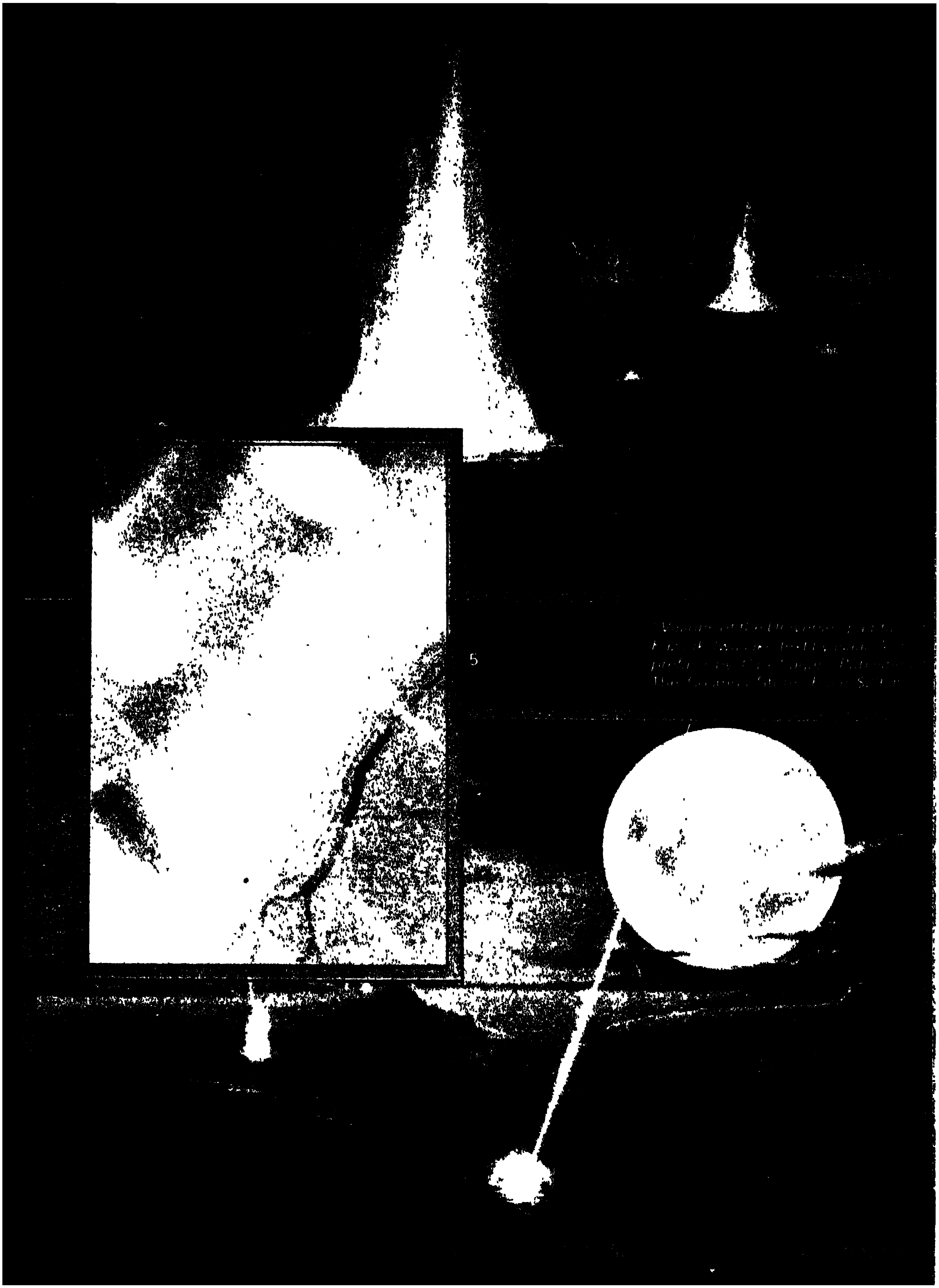
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ENERGY DILEMMA

THE 12th Congress of the World Energy Conference (WEC) was held at New Delhi in September, 1983, with over 3,000 delegates from about 70 countries. WEC is a world organisation in London having observer status with the United Nations.

The theme of the conference was "Energy development—quality of life". Comprehensive confabulations by different working groups on specific subjects like energy conservation, hydrocarbon technology, availability of thermal generating sets and international cooperation were undertaken. A special session was also earmarked for energy scenario in India. All in all, it was a unique venture in cooperative global energy forecasting.

The purpose of all this exercise is to underscore the role and contribution of such a world meet in evolving a global energy strategy with a long-term pespective. Euphoric expectations about concrete projections or future directions, however, soon evaporated during the course of the meeting. Except for mouthing platitudes like: minimising the use of oil and king-coal, and nuclear power as hope for tomorrow, with renewable energy sources chipping in as country-cousins and maturing after the turn of the century, nothing concrete came out of the whole exercise. Ironically, since about half of the energy consumption in our country (and perhaps in other developing countries too) is in the non-commercial sector, not even a token discussion was thought appropriate or necessary on this topic.

Incidentally, the recent World Bank report doesn't seem to set much store by renewable sources of energy, about which it says: "The development, adaptation and application of certain technologies, such as photo-voltaics and biogas-digesters has proved more difficult, and their costs have not come down as quickly as was initially forecasted." Its recipe for the developing nations is to go in for, oil exploration and exploitation of coal and hydel power.

This picture, however, has no foundation in facts By adopting an optimum energy-mix with a sensible balance between nuclear apple and solar orange, India can and should tide over energy transition blues. We have just exploited 12 per cent of the total hydropower potential estimated at 75,000 MW at 60 per cent load factor. Capacity-utilisation of thermal power generation is abysmally low while energy-efficient means and methods cry for implementation by the Indian industry.

The WEC epitomised the inexorable energy transition, which given an optimistic but realistic energy policy characterised by diversity and flexibility, can be smooth and gradual. In contrast, exponential growth in energy demand, with population and environmental pressures on the rise and failure to catch up with other energy options, will perforce make this transition disruptive, even brutal. What is needed is not money but imagination to usher in an era of abundant energy without attendant hazards and ecological implications in the foreseeable future.

Dhirendra K. Dixit

Mr. Dixit, a member of the faculty of mechanical engineering at the Visvesvaraya Regional College of Engineering, Nagpur, is currently on deputation with the Department of Mechanical Engineering at the Indian Institute of Technology, Bombay.

More 'light' on photosynthesis

THE International Congress on 'Photosynthesis Research' is held once in three years and the sixth such Congress was held in Brussels, Belgium from 1 to 6 August, 1983. Traditionally the Congress is attended by a large number of scientists and virtually all the leading researchers working in the different aspects of photosynthesis research are present. The Brussels Congress was attended by over 900 scientists and consisted of 10 plenary lectures, 20 symposia, about 750 poster presentations and a special evening session to discuss "Science and government policy".

The 10 plenary lectures and 20 symposia sessions were devoted to up-dating of our knowledge in different aspects of photosynthesis research, with special emphasis on the developments that have taken place since the last meeting held in Greece.

The different aspects of photosynthesis research discussed at the meeting included the molecular architecture of the photosynthetic membrane, regulation of excitation energy distribution, enzymology and regulation of carbon dioxide fixation, organisation and expression of chloroplast genome, effects of stress conditions on the structure and 'inction of photosynthetic apparatus, development of the chloroplast, structure, biochemistry and biophysics of reaction center complexes from photosynthetic bacteria, algae and higher plants, electron and proton transport, solar energy utilisation by photosynthetic organisms, etc.

The knowledge in different areas is growing fast and some of interesting developments are considered in this report. A major development reported at the meeting related to the lateral heterogeneity in the organisation of the components of the chloroplast membrane. The evidence obtained in the past three to four years using inside-out chloroplast membrane vesicles suggests that the partition regions of the grana in the chloroplast may contain only photosystem II (the photosystem I components seem to be absent from partitions). The stroma-exposed membranes contain all of the photosystem I.

Additionally the membrane appears to be a dynamic structure. There is now convincing evidence to show that phosphorylation of the light harvesting pigment protein complex (an intrinsic membrane component) results in its lateral diffusion in the membrane. The phosphorylation-induced mobile nature of this pigment complex permits the membrane to deliver, in a regulated manner, the excitation energy to the two photosystems. Thus the rate of turnover of the two photosystems which must function in series, is critically balanced by the dynamic nature of the membrane to achieve maximum efficiency.

The precise function and characterisation of different electron transport components is also becoming clear. The structure, subunit character and proton pumping function of cytochrome f/b6 complex was reported.

There has been a hectic activity in understanding the organisation and expression of chloroplast genome. The mapping of the circular DNA of chloroplast has progressed further. The mapping and identification of products of photogene 32 was reported—these photogenes are not clustered but are dispersed. Also only about 16 per cent of the genome is responsive to light and is estimated to be 17 kilo base pairs (KBP). The gene coding for herbicide binding protein is chloroplastic and has been sequenced.

The gene-cloning techniques have proved useful in determining the amino acid sequence of polypeptides (by nucleotide sequencing) and several membrane polypeptides have been sequenced by this approach. Using the newly developed concept of "Hydropathy plotting" from the amino acid sequences, the possible structural arrangement of the molecule in the membrane can be deduced. Using these techniques, several workers proposed excellent working models for molecular folding of the membrane components and attempted to explain their function.

Biochemically, besides investigations on the characteristics of different enzymes involved in carbon dioxide fixation ferredoxin/thioredoxin system, regulation of about a dozen of enzymes in higher plants and cyanobacteria was reported. A new finding in this area is the demonstration of the involvement of ferredoxin/thioredoxin system in non-photosynthetic cells also. Another interesting development was the identification of fructose-2, 6-biphosphate, as a regulatory metabolite governing the synthesis and breakdown of sucrose. It appears that the chloroplast communicates with the cytosol through this metabolite.

There were also several reports on the effects of different stress conditions on the enzymes of the plant. Some presentations related to the effects of increased carbon dioxide concentration on the metabolism of plants. This area should gradually acquire importance as the carbon dioxide concentrations in the atmosphere is predicted to rise gradually. For the Indian scientists this may be a useful area of research.

At the meeting, biophysicists reported the structure and composition of the multi-subunit reaction center of the photo-synthetic bacteria. Several studies on the organisation of the photosystem II reaction center were also reported. Suggestions for the function of different polypeptides were made. The water oxidising enzyme continues to provide challenges to the innovative investigators.

The proton pumping and synthesis of adenosine triphosphate was another area of considerable interest. There were also reports on productivity aspects and hydrogen-generation through biological systems. The hydrogen production using marine, blue-green algae seems to be worthy of attention. The Congress also discussed other aspects of photosynthesis, not only in higher plants but also in cyanobacteria and photosynthetic bacteria.

The overall impression one got from the deliberations at the Congress was that tremendous developments are taking place in the basic research related to chloroplast function. The techniques of genetic engineering have been successfully utilised by the scientists in gaining basic understanding of the membrane components and their organisation. The applied aspects, barring the herbicide research, continue to make slow progress.

P. V. Sane

Dr. Sane is Deputy Director of the National Botanical Research Institute, Lucknow. Formerly, he was with the BARC actively involved in research on photosynthesis

Artificial chromosomes

EACH eukaryotic cell (a cell with a true nucleus) contains a constant and species-specific number of paired or diploid chromosomes. The total complement of individual chromosomes is termed the chromosome number. The chromosome pairs exhibit great differences in their length, shape and size but on an average their length varies between 1 to 15 micrometres. The shape of each pair during cell-division depends on the location of the centromere, a body that controls the movement of the chromosome in cell division. In fact, the position of the centromere is characteristic for a chromosome and defines its short and long arm. Telomeres are the physical ends of the chromosomes and are responsible for their integrity.

Chemically, chromosomes consist of deoxyribonucleic acid (DNA) combined with certain basic proteins (histones), more complex proteins and ribonucleic acid (RNA). New chromosomes originate only through duplication of pre-existing ones. And this takes place during cell division.

Until recently, these structures were studied mainly by indirect procedures. However, the results reported recently (*Nature* **305** 189) by Andrew Murray and Jack Szostak from the Harvard Medical School, USA, enables the scientists to clone structural domains of chromosomes. In other words, it is now possible to construct artificial chromosomes from cloned fragments of DNA. This has opened the way for understanding and exploring fully the mechanics of chromosomes. The authors succeeded in introducing a chromosome built in vitro into the yeast cells; the information contained therein was copied faithfully and passed on to the daughter yeast cells.

In their task of creating an artificial chromosome, the scientists heavily relied on the work of Louise Clarke and John Carbon of the University of California at San Diego. Clarke and Carbon had isolated and determined the full DNA sequences of centromeres from yeast chromosomes. To one such characterised centromere, Murray and Szostak added autonomously replicating sequences (ARSs). These sequences are capable of promoting extrachromosomal replication of plasmid DNAs. The genes which they selected for their chromosome enabled the cell to manufacture its own leucine and uracil. These are important substances as they have to be supplied in a ready to use state to the recipient cells. This ability to produce leucine and uracil facilitates the identification of cells transformed by the newly-introduced artificial chromosome.

Addition of telomeres allows plasmids to be perpetuated as linear molecules since efficient separation of these structures during cell division is greatly helped by the linearity of chromosomes. These special sequences (telomeres) were taken from a protozoan, *Tetrahymena*, and were added to the ends of the artificial chromosome.

This in vitro constructed chromosome was functional but not very stable. This instability was due to, at least in part, the small size of the chromosome. These studies have provided supporting evidence that a centromere is required for efficient segregation only and has no role in homologue recognition.

At the moment these artificial chromosomes are not important in yeast genetic engineering, for most industrial applications require large number of engineered genes rather than a single copy. The impact of this remarkable event will be in mammalian genetics, specially in the therapy of genetic diseases. The greatest hurdle in the therapy of genetic diseases is the inability to replace the defective gene with a new gene at the correct place on a chromosome. Now, these artificial chromosomes offer a solution and it is likely that in the not too distant future it will be possible to replace the chromosome carrying the defective gene at the appropriate stage of an individual's development.

Tariq Haqqi

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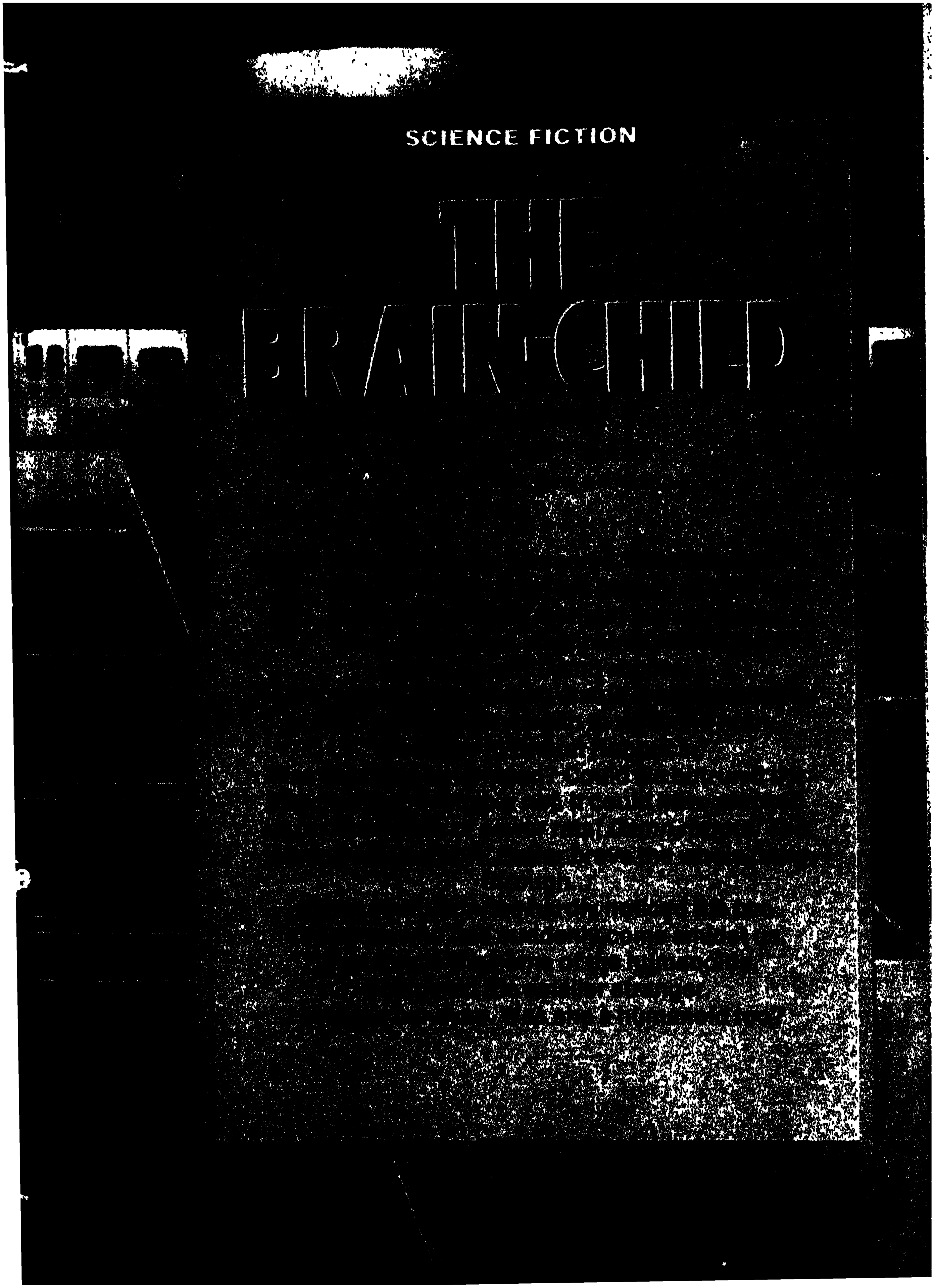

SCIENCE FICTION
THE BRAIN-CHILD

Damn robots! Robots are a threat to privacy, to creativity. They destroy family life. They form inhuman bonds of friendship...

Where had the two strangers been hiding all this while? Was it a trap? Everything about the female stranger seemed so *chic* and well-manicured: the coiffeured head, the flawless skin and the intelligent eyes... The robot manufacturers had chosen their PR personnel well. Or was it all carbonised alloy? Down with robots! May they fizzle in eternity!

I controlled a mad impulse to whirl around and slap the girl's head off! Would that wipe off her smile? Oh to yank off that hateful perm out of her hair! But on the other hand, why should I? I could well imagine the bedlam on the cosmocom...terrible publicity for the Cause.

I could predict the lurid headlines my attack would evoke: *"Greenman goes berserk", "Man bites bot."* There would be days of vicarious thrill for the dome population languishing in a denatured environment. It would only serve as one more red rag to the robotmakers to retaliate with their soporific advertisements. *Damn robots!"* Besides, we must not forget the main purpose of our visit.

My wife and I are founder members of the "Back To Nature" movement. Robotmakers derisively refer to us as LGMs, little green men. But we don't mind really. Afterall, *we do* advocate the Green Way, life natural, living harmonious with all things natural. This automatically (or naturally) puts us in conflict with the robotmakers.

But believe me, we hate conflict--especially with humans. It is the robots we detest. Robots are truly an excrescence, the metallic pimples upon the face of a mechanised civilisation that is terminally ill. Damn robots! Robots are a threat to privacy, to creativity. They destroy family life. They form inhuman bonds of affection with the lonely children of the hedonistic parents they are supposed to serve. They undermine every human relationship. Robots will ultimately be the death of humanity.

For us apocalypse is a monstrous mechanical maw that swallows humans and spews out mechanised morons... Already the signs abound: robots alienating young ones from their families, robots "softening up" young men and women, robots controlling all aspects of our life in the cities.... Robots! Robots! Robots! There's scarcely a place on earth today where one can escape from these mechanical monsters. Go anywhere on the dome, to Tundra or Sahara, and one of these regulation "bots" will be present, grating and purring, ever alert to your welfare, ever admonishing you with dos and don'ts.

Penned like cattle as we are in these super-cybernetic cities, we had to rebel! But who would have thought that a leading cyberneticist and his systems analyst wife would cast the first rock? That, too, in India? Imagine India, when the rest of the galaxy had already accepted (or had been forced to accept) robots as indivisible parts of a civilised human life?

But don't forget India is an ancient land...land beyond memory...the land where man first "saw" Truth and burst into speech and song. The first seeds of the mighty tree of numeracy were laid in our land. Thus it was but natural that someone Indian lead the revolt against robots when these *manusputras*, cybernetic children sprung from men's minds, began to stifle their own masters ....

However, our revolt is still to spread. Our doctrine of a life totally self-sufficient, a life devoid of mechanisation, is too radical, too liberating. Most people are afraid of freedom. For generations they have bred and died in the robotised environment. They cannot but distrust the new doctrine, the little green men, that challenge the only world they've ever known.

At first even our own children rebelled against us, against what they called "bonkers behaviour".

"Oh, papa why have you ripped off the visiphone?" wailed our younger child "Now I can't ever receive the messages from my friends. And you *know* I am no telepath...."

"Forget the visiphone," fretted his elder sister. "We don't even get a menial rob for handling our garbage transforms. Imagine what it does to our resource bill! No more candy!"

Gradually however, both our children reconciled to life without their "beloved" serfs. They even allowed us to move out of the dome. Once outside that claustrophobic trap they began to change and adapt with a rapidity that astonished us. Perhaps it was the lack of mindmending drugs. You all know what the lemming life in a megapolis does to you. Without the soporifics which come from your water supply itself, you would either explode or quietly and completely go to pieces! Still, it is surprising how many people prefer the over-crowded domes. To this pampered majority of hedonists, life outside in the green is unthinkable

It is all part of an enormous confidence trick, an immense hoax which keeps vast numbers of dome humans in happy, benumbed bondage. And, yes, it makes the robotmakers rich, very rich indeed.... The robotmakers pull the real strings these days, not the politicians.

At first the robotmakers simply ignored us. After all there *have* been protests before. Entire families would forsake the womb-like security of the dome. Sometimes stragglers would return, begging to be let in. But most of the venturers were never heard of again. The forests and the fields that swallowed them remained inscrutable in their verdant lushness. However, with our knowledge of Neotechnics, we felt we had a fair chance of beating the system. Also, not all dissenters were dead. Out there on the sward, we occasionally met survivors like ourselves—doughty men and women who had forsaken the dome generations ago.... Their powers had blossomed out in the most unexpected manner.

Where we differed from these "wild ones" is that we very much wanted to be within the galactic empire, but without the stultifying service of the robots. We were willing to try anything, however bizarre the technics. But upon one thing there was to be no compromise: no robots! Eventually,

Yes, sometimes I do long for the dark angel of death, for the quiet oblivion of its embrace. For I know what it feels to be caressed by death's wings...

Robotmakers' Conglomerate had tried every means in their book to "convert" us from our so-called error. Why?

We were too successful. That is why! And the very success of our village, so near their dome, was a threat to their mindnumbing utopia. Initially their PR people tried to plant horror stories about our plight on the green. But the cosmocom cameras told a different tale. Why did we look so ruddy, so full of life? Why were our beds and bowers so full? Why were we at peace? There was only one answer, because we had abjured the robots; because we trusted and followed the Green Truth; because .. enough! To babble further would be to reveal the mysteries!'

When the robotmakers failed to discredit us they had tried artifice, even treachery. But nothing can shake a person well grounded in the lap of Mother Nature. At last the robotmakers had called for a confabulation. Could we refuse? Who knows, we might even be able to convert these misguided souls! We could physically demonstrate our superiority. We knew the eyes of the entire galaxy would be trained on these epic parleys. We would do nothing to spoil our image. Just think of the unsaved generations lost in the psychedelic alleys and byways of the domes, not only on earth but elsewhere...

That is why we were so nervous... so afraid of failure. One could never trust the robotmakers. They could be upto anything, even annihilation.... *May Green save us. Down with Robots! Back to Nature!*

So The greenmen have arrived. They seem so relaxed, yet so alert... especially that leader of their's, Manav Chaudhari His vibrations are strong and sharp. He is hiding some strong emotion... what a striking wife he has. Oh, the poor besotted souls! Don't they know how wrong, how utterly wrong they all are? Their heads should be mapped. Who but a fool would desert the mother embrace of the dome, the dome of togetherness.. its myriad mindsports, the tactile joys of the crowd, the heat of all that human flesh pressed together ... Ohhhh... the mere thought of it brings on Samadhi...

I am Aloke, Sector Chief in charge of robot assemblies, the sole human responsible for all these cybernetic children you see here. They're all sweating their sockets off For what? All for you pampered humans .. for your welfare, for your pleasure, all for free. What more can one want?

Oh, I almost forgot. I am not talking to robots who reason logically I am

talking to humans. Humans that prefer an apple (or was it a fig?) to paradise! To be human is to long for hardship in the lap of luxury, to crave for death in the face of immortality. You may ask, "How do you know? Do you long for death in the face of immortality?"

Yes, sometimes I do long for the dark angel of death, for the quiet oblivion of its embrace. For I know what it feels to be caressed by death's wings . I have been there and I should know! My only regret is that my dear wife Usha and daughter Sona could not make it back with me from the world beyond words...

Ever since the accident and my miraculous recovery, I have been confined to this master control room in the faithful company of robots... doctors' orders... They say I am not yet ready for the heady surge of the crowds outside. The accident that nearly sent me over is the one item I wish to take up with the greenmen. I know they were connected with it. How else can one explain the mysterious malfunction of the special coaster vehicle which some of Manav Chaudhari's minions were working on? The very vehicle that I reluctantly agreed to try out "for a spin" because of my beloved Sona... Well, we shall settle all scores by end of this evening.

No one knows what happened at the stormy meeting between the leader of the greenmen and Chief Aloke of the robot assemblies. Even the holograms have been tampered with . But robots have eyes, you know, even if they are C grade and compound ones... Some whispers have already begun to leak from the machines that were on duty in the master control room on that fateful evening. As leader of the riot police summoned by the Chief, it is my duty to investigate the truth and to supress it...

According to one garbled account we received from a robot, the greenman and the pink master (Chief Aloke) had angry words during which the Chief repeatedly thumped a table, so hard that it broke down Yet the pink master who is otherwise so sensitive, felt no pain at all. At this, both the adversaries grew frightened, especially the pink master who seemed to go berserk, smashing everything in sight with his hand that neither bled nor broke ... And it was the greenman who first

(Continued on page [illegible])

A FINERY OF FEATHERS

AS a schoolboy I once found a small dead kingfisher in our garden at Mulund in the suburbs of Bombay. The petite bird, with its coral red beak and jewel-like fawn and purple feathers, looked so exotic that I thought it was an escapee from some princely aviary. Or was it a hapless migrant blown off its secret route far far away from Bombay? Whatever it was, I was unable to identify it. None of my books listed it. Perhaps it was a species unknown to science. For a while I toyed with the idea of naming it in the honour of the girl who lived next door. But, alas, that was not to be!

Only a few days later, I found my nameless kingfisher in a splendid American volume, *Birds of the World*, which I received as a gift (*circa* 1960) The bird, popularly called "living jewel", turned out to be a Three-toed Forest Kingfisher. Apparently it was widely distributed, not only in India but also in Burma and South-East Asia. It had already been classified as long ago as 1758 by the father of the binomial system of nomenclature, the Swedish naturalist Linneaus'

So much for my "discovery". But the point is, without Arthur Singer's painting in *Birds of the World*, I would never have been able to identify the kingfisher on my own.

The adage "one picture is worth a thousand words" applies with as much force in birdwatching as in journalism. Indeed, in birdwatching those proverbial thousand words often prove inadequate. For instance, take the Monal Pheasant that lives in the Himalayas. One could use all the words in the

A kaleidoscope of kingfishers.

Concise Oxford Dictionary—over 40,000 of them—and yet fail to evoke or capture the finery of its feathers!

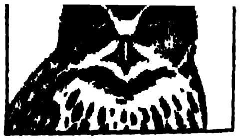
One man who has ceaselessly been evoking the "finery of feathers" for generations of birdwatchers in India is Dr. Salim Ali. (It is Saalim with the diacritical mark and not *Salim* as in Salim of "Anarkali" and "Mughal-e-Azam" fame! Dr. Ali points out with characteristic piquancy, that most people not only get his name wrong, but also "correct" those who say it right—even while he is present!)

Dr. Salim Ali's celebrated classic, *The Book of Indian Birds*, appeared in 1941. It has gone through eleven editions; the latest (1979) has 74 plates depicting 296 species. Although the *Book* (and other volumes by Salim Ali like *Indian Hill Birds, Field-guide to Birds of Eastern Himalayas*) is invaluable for the commoner birds, it represents barely 15 per cent of the total number of birds—1,220 plus species—found on the Indian subcontinent.

For the majority of our birds, therefore, one has to turn to the magnum opus, Ali and S. Dillon Ripley's *The*

Handbook of Birds of India and Pakistan. This unsurpassable classic, which appeared between 1968 and 1974, is spread over 10 volumes. The long-awaited compact edition in a single volume has recently been released. It is a marvel of publishing and a veritable mine of information. One cannot fail to unearth real gems even in one casual browse. For instance, you have heard of the cruel slaughter of egrets for feathers which drove these elegant birds to the brink of extinction. But did you know that for decades, a community in

Eagle owl* (left) *and a portion of the plate from the* Guide *showing the diversity of magpies, jays and treepies in India



The *Pictorial Guide* is indeed a landmark... the first book to illustrate *all* our birds.

Sind has been "farming" egret feathers painlessly and effectively? As I devoured page after page of the *Handbook* (yes, it is possible *without* glasses, despite the small print which is the result of "compacting" four pages of the regular *Handbook* onto one), I could only marvel at the vast erudition of the authors and the sheer physical labour involved in producing such a monumental work.

While autographing a copy for me Dr. Ali said, "The compact *Handbook* weighs a hefty two-and-a-half kilos, you know!" Jokes apart, one can't obviously lug around such a book in the field, especially if you're chasing birds (feathered)! So, for birdwatchers in the field, Dr. Salim Ali and Dr. S. Dillon Ripley have another bonanza—the *Pictorial Guide* which depicts *ALL* the birds listed on the subcontinent. Will wonders never cease? This book is indeed a landmark. For it is the *first* book to illustrate all our birds (some of them for the first time). Even the *Handbook* covered only 900 of the 1,220 plus species. Moreover its plates, drawn from several sources, are not grouped systematically. In the *Pictorial Guide* you have all the species arranged family-wise on 106 plates which follow each other in a systematic easy-to-find order. The illustrations are excellent (if trifle monotonous in their rigid, cloned profiles). How excellent can be seen from just one example: Last week a friend who returned from Jaipur described a long-legged bird which she saw outside her resthouse. She wanted my help in identifying it. From her talk, the bird seemed to be a lapwing. So I showed her the *Pictorial Guide*. In a jiffy she pointed out the Sociable Lapwing: "That's it—the leggy bird with black and white wings and tail, a white eyebrow, a pirate like black band through the eyes!" I tried the Double banded or the Jerdon's Courser on her. "Could it be this bird?" I asked. She emphatically said no. I was both relieved and disappointed—experts say the Jerdon's Courser is extinct! It was last seen in 1900. It was only found in the Godavari valley in Andhra! The lady did not know all this. She merely said the bird I had shown had a brown neck and double stripes on the head which *her* lapwing did not have! Remarkable. What is more remarkable, in this book you can actually compare the birds like to confuse you and correctly identify them in the field.

Now, had I referred the lady to the compact edition of the *Handbook of Birds of India and Pakistan*, she would probably have been "frightened away by the mere wealth of material and the technical terms used in the descriptions". (The words are the late Hugh Whistler's, the eminent ornithologist who pioneered the use of excellently illustrated field guides in India with his *Popular Handbook of Indian Birds* (1929). Whistler was describing the plight of a novice who goes to search for a common bird in the monumental *Fauna of British India* series.)

That is not to slight the compact *Handbook*. On the contrary. As I said in an earlier review of this magnificent book: "No Indian birdwatcher worth his salt can afford to be without this treasure-trove, this Court of Last Resort of Indian Ornithology"! The same must be said about the *Pictorial Guide*. Incidentally, the reviewer in the *Illustrated Weekly* complained about the price of the *Guide* (Rs. 120). Yet he went on to add: "If you can't afford it, steal it!"

That brings us to the question of price. These days, when "cheap" paperbacks cost over 60 rupees, how is it that a hardcover such as this costs only 120 rupees? The introduction to the *Guide* provides partial answers:

The paintings are the work of John Henry Dick, an eminent illustrator, closely associated with the Audubon Society and conservationist organisations like the Crane Foundation. Both the authors and the artist have munificently *waived their royalties in favour of the BNHS*. Similarly, this useful work has been sponsored by the US Fish and Wildlife Service and Smithsonian Institution, Washington! (Incidentally, Dr. Ripley is the present Secretary of the Smithsonian.)

I can only say more power to such collaborations. But the question remains: why couldn't we on our own, with Indian Government support, have produced such works much much earlier?

As it is, I hope the *Pictorial Guide* starts a resurgence of interest both in birdwatching and in conservation and in the ecology of our sore-pressed land. But like Oliver Twist, I would like to ask for more: first, the 30 black and white plates in this work should forthwith be rendered in colour in the second edition, the demand for which is bound to soar. There is nothing more depressing than having to tackle a warm, coloured bird in a black and white illustration. Have you seen the fabulous Flamingo? Just because its colours tend to be monochromatic (shades of pink) is no excuse to have it in black and white! Moreover, the crucial vignettes of some of our birds of prey are in black and white. From my frustrating experience in the field with these raptors, I can only say how unsatisfactory this is.

Secondly, what we need are not only profiles but also illustrations of birds in flight, their variable plumage, the immature phases, with tersely written commentaries on behaviour, calls, etc. The *Guide* does provide some information about status, size and distribution. But that is all. For details one has still to depend on other texts like the compact edition of the 10-volume *Handbook*.

In the final analysis, it is unfair to expect all this from what is obviously only a *pictorial* guide. The authors and the artist richly deserve our thanks.

Vithal C. Nadkarni

***A Pictorial Guide to the Birds of the Indian Subcontinent. By Salim Ali & S. Dillon Ripley; with 106 plates depicting *all* the birds by John Henry Dick. Bombay Natural History Society Centenary Publication; Oxford University Press 1983; Price Rs. 120**

***Handbook of the Birds of India and Pakistan (compact edition)—By Salim Ali and S. Dillon Ripley. Oxford University Press 1983; Price Rs. 600**

WILL VOTING GO ELECTRONIC ?

The Presiding Officer at a polling station explains the procedure of voting to one of the voters.

THERE will be no tampering with ballot boxes, no spurious ballot papers, and, more important, no invalid votes, if the electronic voting machines are used in the next general elections. And all the counting will be over in a few hours. But will they be used?

In a meeting with the Chief Election Commissioner last month, representatives of all parties, including the ruling party, agreed that the electronic voting machine may be introduced in the entire country by the next general elections as far as practicable. The Election Commission said it would convey this view to the government.

The Commission has indeed been contemplating the use of electronic voting machines on a wider scale after its initial success with the machines in some constituencies in the last two years. The Commission had last year recommended to the Government to introduce the machines for elections in the entire country in phases within three years. The Central government agreed in principle and also made a token provision in the budget, but did not agree to the coverage of the entire country within three years, probably for financial reasons.

The Commission feels that the electronic voting machine is an answer to many problems now faced in polling. And the entire amount spent on buying the machines for a general election could be offset within three general elections to the Lok Sabha and the Assemblies because of the savings on other expenses. For these reasons, the Commission asked the Government to revise its decision, but once again the Government turned down the recommendations.

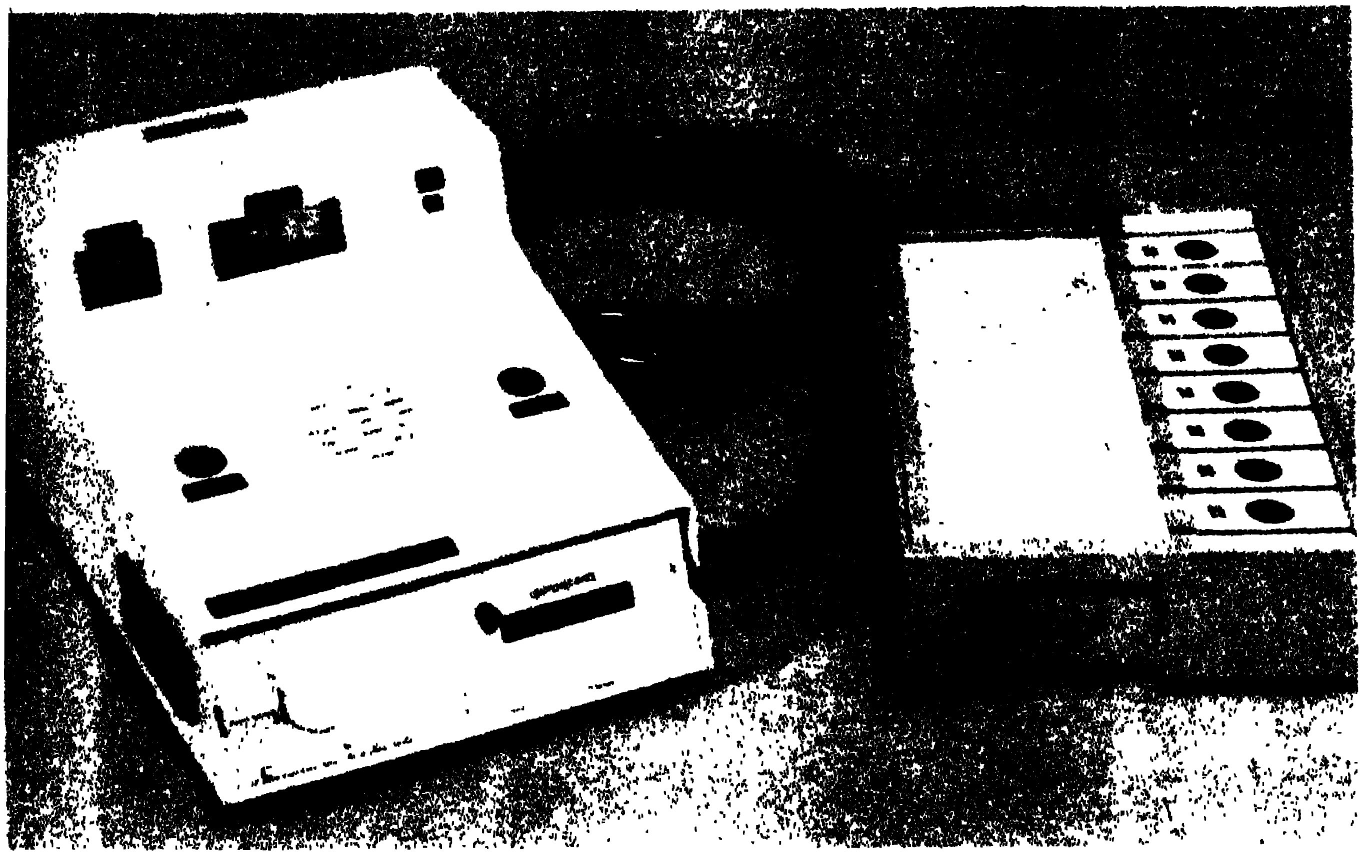
Electronic voting machines were first tried on an experimental basis in 50 polling stations in the 70-Parur Assembly constituency in the general election to the Kerala Legislative Assembly in May 1982, and later that year in Nagaland. Since then, they have been used in some areas for elections to the Karnataka, Andhra Pradesh (where the machines were used in all the polling stations in the Shadnagar Assembly constituency in January last year), and Tripura Assemblies, the Delhi Metropolitan Council, and bye-elections in Arunachal Pradesh and Bihar (where the machines were used in 159 polling stations in July 1983).

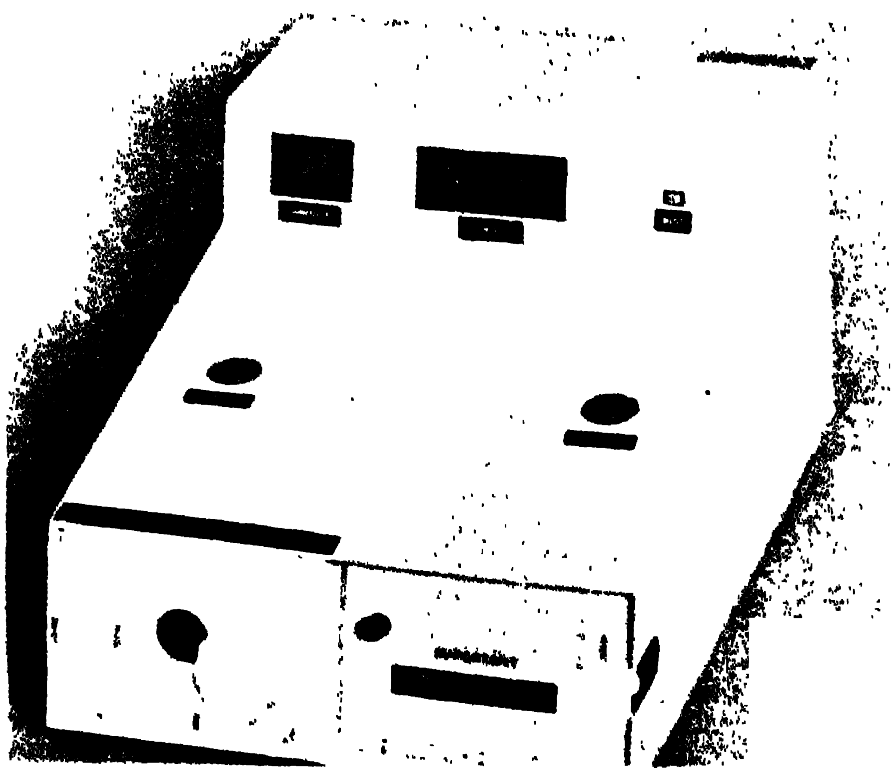
According to the Commission, these trials have been highly successful. And people in general, the political parties and the contesting candidates have fully accepted the machines. All agree that the electronic voting system is quite simple and much quicker. The routine complaints of printing of ballot papers and the use of spurious ballot papers are totally eliminated; in fact, there is no ballot paper to use—the voter simply presses a button in the machine and the vote is registered. Nor are there any cumbersome cross-marking within the allotted space and consequently the large number of invalid votes. The votes are then counted in a matter of minutes and there is no scope for mistakes or irregularity in counting.

Since the ballot paper is eliminated, so also are the enormous expenses on stationery and printing these papers, the elaborate work of checking and verifying, and the security measures in keeping and transporting the ballot papers. This also means that elections can be held at a short notice. There is no need to sort and count the ballot papers and, since each candidate is provided with a separate electronic pocket for his votes, there will be no mix-up of votes.

A great advantage is that there will not be a single invalid vote, says Mr. P. L. Sivaram, the Chief Electoral Officer of Andhra Pradesh where, as mentioned earlier, the machines were used in all the 150 polling stations of an Assembly constituency in the general elections last January. "When there are no invalid votes, the question of recount does not arise. In the conventional ballot paper system, there were cases where I ordered a recount when there was a difference of the order of 24 votes. Recounting means that the Returning Officer has to go into the question of validity of each vote and repeat the entire counting procedure. This is a grilling and long drawn-out process. When the voting machines are used, in case of recounting, the return-

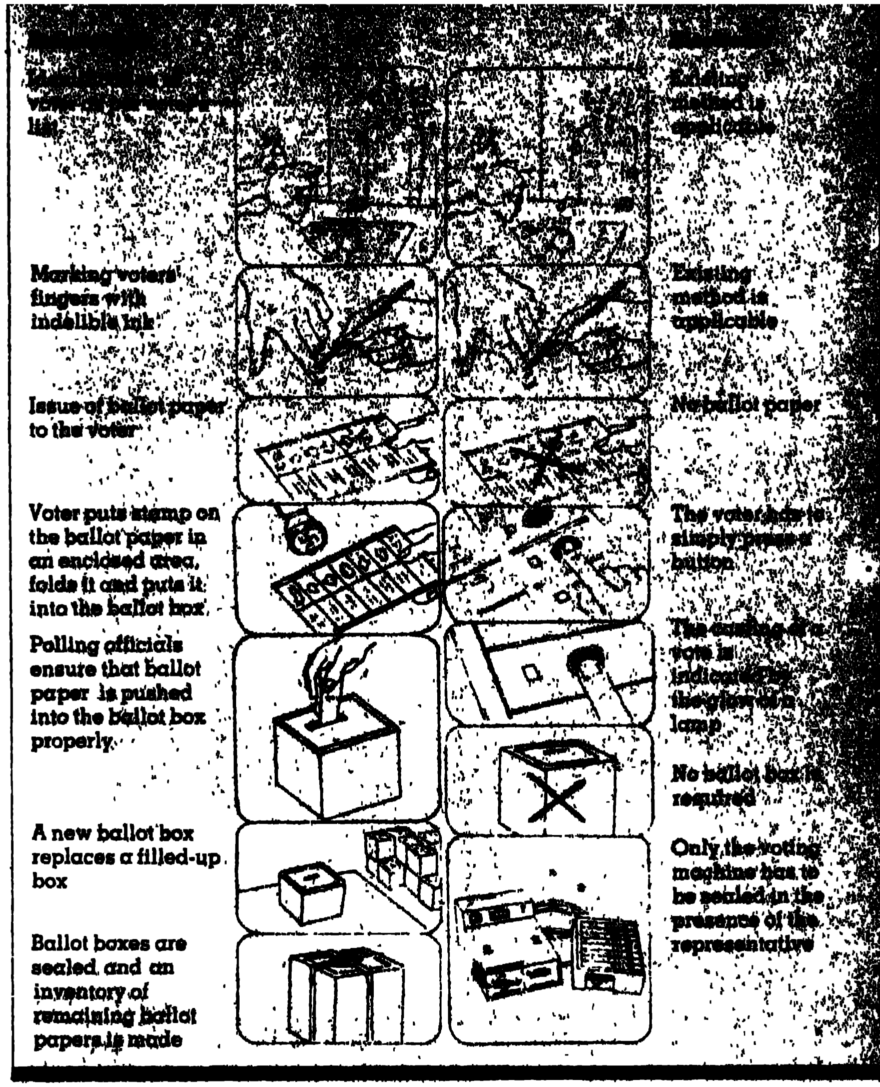
Electronic voting machines can solve many problems now faced in elections, like tampering with ballot papers and a large number of invalid votes





The electronic voting machine (above). The ballot unit (right) is connected to the control unit (left) by a five-metre cable. The ballot unit carries the names and symbols of candidates, a push button (black circles on far right) against each name for registering the vote and lamps (red squares) which glow when the vote is registered

The control unit shown separately on the right has a two-digit display (top left corner) and next to it, a four-digit display for votes polled. Next to it (top right) is the busy lamp, which indicates whether the machine is ready to accept a vote or not



ing officer will just press the result button and the results are displayed again within five or ten minutes." Similarly, the votes polled by each candidate can be counted at the press of a button and the results declared within a few hours after the polling. This also makes it possible to hold elections throughout the country on the same day with the results too declared on the same day.

Can the secrecy of voting be maintained using the machines? While a voter has to sign on a counterfoil bearing an identical number as that on the ballot paper he uses in the present system, he has to sign only in a register in the new system. This rules out the identification of the voter, says the Election Commission. At the same time, the register is open for inspection by anyone who wants to collect evidence to challenge an election on the grounds of impersonation or bogus voting. This facility is, in fact, not available in the present system, for the counterfoils of the used ballot papers are sealed and cannot be opened except under Court orders

Thus electronic voting machines make elections toolproof, efficient and less expensive, needing less resources, manpower, and time.

How do the machines work? The machine has two units-- the control unit and the ballot unit (see p.48). The ballot unit, which is used to register a vote, is kept in an enclosure, and the control unit, connected to the balloting unit by a 5-metre cable, is kept such that the display on it can be seen by the Presiding Officer, representatives of the candidates and voters.

The balloting unit carries a panel of names of eight candidates and their election symbols, with a push button provided against each name and symbol. To cast his vote, a voter simply presses the button against the candidate of his choice. A small lamp (voting lamp) next to the push button lights up to indicate that the vote is recorded. The cable carries the data to the control unit.

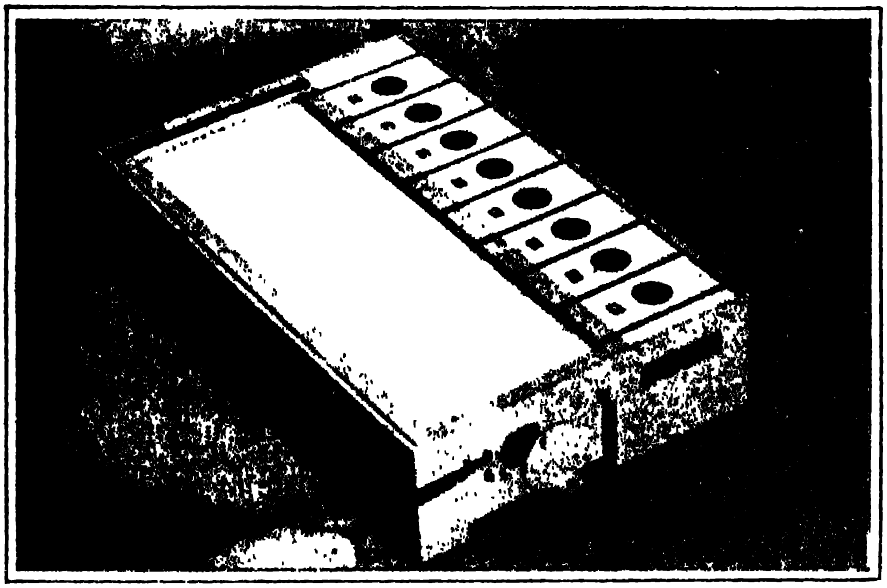
The control unit, which has a microprocessor, first gives a visual indication of its readiness to accept a vote and then an audio indication whenever a vote is registered But its main functions are to permit each voter to cast one vote, record the votes cast in favour of each candidate, record the total number of votes polled, and display, on demand the votes polled by each candidate and also the total number of votes polled. It retains these data for future reference and erases the previously recorded data It can also detect and display an error

The balloting unit can accommodate eight candidates. When there are less than eight candidates, the unused voting buttons are electronically disabled by the control unit. To avoid confusion, the unused buttons may be covered When there are more than eight candidates, another balloting unit is used and is connected to the first one, and so on (there is no need to connect each balloting unit to be connected to the control unit separately), the memory is designed to accommodate 56 contestants, that is, seven balloting units connected in series.

The control unit has a 4-digit display for the total number of votes polled, that is, it can display up to 9999 So where the total electorate is less than this number, one machine can be used to cover two or more nearby polling stations whose total electorate does not exceed 9999 This will reduce the total number of machines required, and consequently the number of polling officials There are about 4.5 lakh polling stations in the country now, and the Election Commission hopes that it may be possible, by such combinations, to reduce this by 30 per cent or by about 1.35 lakh polling stations. Besides, mobile polling stations and staggered polling hours may also be a possibility.

Once the polling is over in a polling

The candidate list with symbols is inserted into the protective transparent cover of the balloting unit



The circular opening through which the ballot paper panel can be opened. A circular disc covers this opening and is also used to seal the opening (above)

station, the machine is sealed and transported to the counting centre. If the election rules can be suitably amended and the Assistant Presiding Officer in a polling station is given the power to give the local result in the polling station itself, this also could be avoided (this is possible because there are no invalid votes, senior officers are now sent for counting to decide the validity or otherwise of a vote) All that the polling officer has to do is to press the result button, write down the result in the prescribed form and send it to the counting centre where all the results are just added up

Though why the government rejected the Election Commission's proposal is not clear, cost seems to be one of the reasons. Each machine (manufactured now by the Electronics Corporation of India and Bharat Electronics Ltd) now costs about Rs. 5,000 but could be brought down to Rs. 4,500 on mass production and if certain components are exempted from import duty. So that it could use the machines in the entire country within three years, the Election Commission had suggested to the Government of India to make an annual budgetary provision of Rs. 50 crores from 1983-84 onwards. The state governments were also requested to make similar provisions in their budgets and to share the expenses with the Centre.

If this cost seems very high, the Commission argues, that there will be a saving of Rs. 3.6 lakhs per each parliamentary constituency on stationery, printing, transport and manpower costs. And for each general election to the Lok Sabha and the State Assemblies in the entire country, expenses could be reduced by Rs.19.5 crores, a total saving of Rs.39 crores for a round of both elections. Further, it suggests, the machines could be lent for elections to local bodies, co-operative societies, etc and this could save another Rs. 10 crores. Thus, even though the initial capital cost is high, the Commission estimates that the entire cost could be recovered in three rounds of general elections.

In any case, the Commission points out, it will have to replace all the ballot boxes for the next general elections. At the rate of five ballot boxes per polling station, including spare boxes, a total of 22.5 lakh boxes will have to be procured for 4.5 lakh polling stations. Since each box costs Rs. 150, the total expense on this alone will come to Rs.33.75 crores, which will have to be shared between the Central and state governments. This expense could be avoided if the electronic machines are used. Compared to this, the recurring costs on voting machines would involve changing of batteries (which costs Rs. 15 to Rs. 20 each).

There is another point to consider. What if the machine fails during polling? This could create a problem. "At Shadnagar, as we were experimenting for the first time with the voting machines we had printed all the necessary 92,000 ballot papers also as a precautionery measure, just in case there was any problem with machines", says Mr. Shivaram. "Of course, there was no need to use the ballot papers. And as we gain more experience and grow in confidence, we can reduce the precautionery measures gradually by 50 per cent, 70 per cent and 90 per cent until we can eliminate all the printing of ballot papers except the postal ballot and tendered votes which is a small percentage (about one or two per cent) of the total votes... But we should be able to achieve cent per cent performance of the machine in the future also when they are used in other elections." On the basis of the experience at Shadnagar, some suggestions had been made to improve the design.

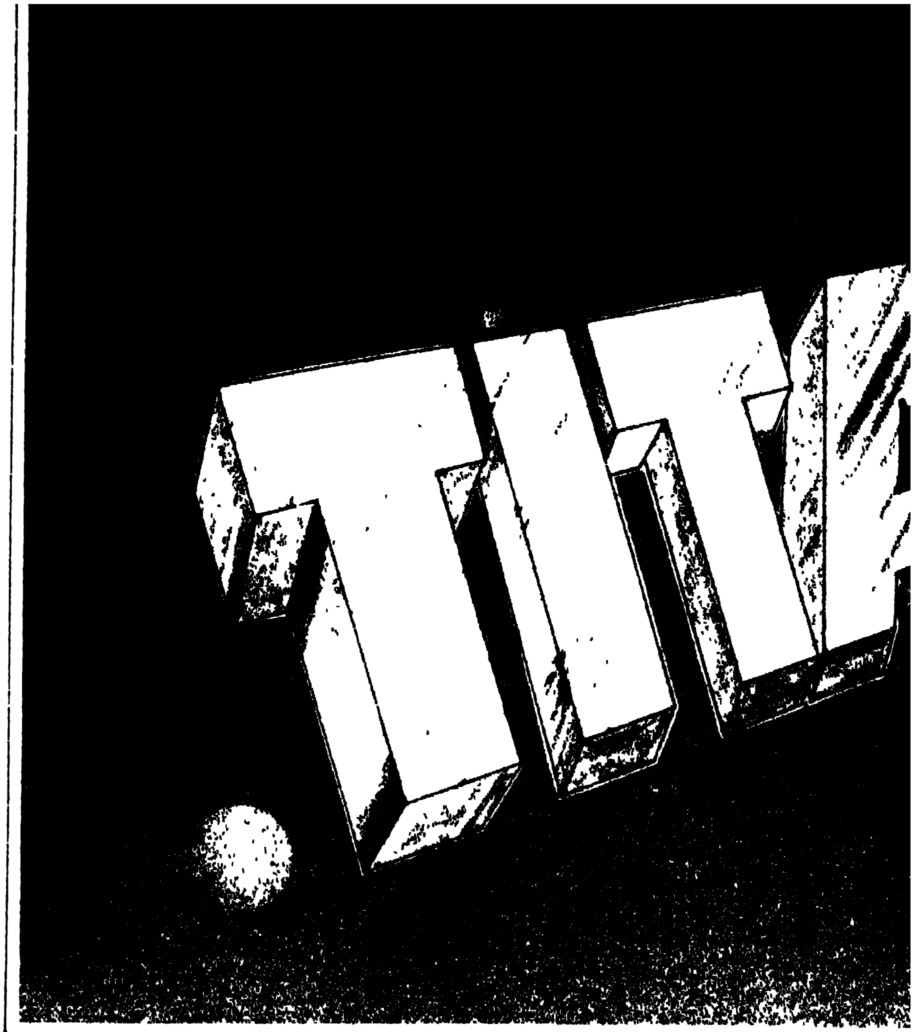
Resources for tomorrow

THE METAL WITH A FUTURE

R. M. Sathe

THE Concord soars smoothly at supersonic speeds over the Atlantic. The orthopaedic surgeon repairs grandfather's fractured femur. The laboratory walls are getting a coat of a lustrous white paint. A desalination plant is being built in an arid zone near the sea coast.

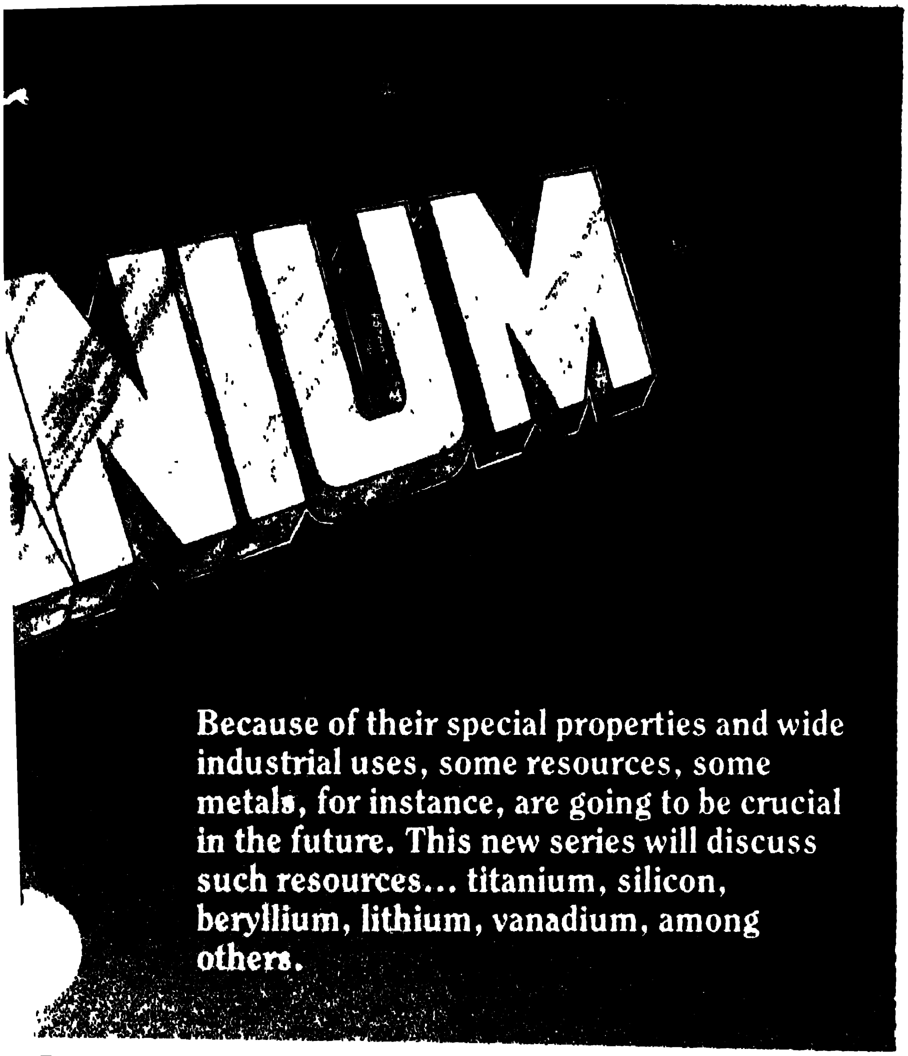
Is there anything common to all these disparate events? Yes, they all involve the use of the element titanium in one form or another.



Though less familiar, titanium is not a rare element. It is actually the ninth most abundant element in the Earth's crust, much more abundant than the more commonly known elements like copper, lead, zinc or phosphorus. The oceanic crust shows a larger abundance of titanium than the continental crust. Apollo 11 and 17, which touched the eastern half of the Moon's surface, brought back samples of lunar basalts, having a very high percentage (10.8 and 12) of titanium.

This element was discovered by Reverend William Gregor in England in 1791. In addition to his ecclesiastical duties, Rev. Gregor found time for his mineralogical and geological interests. His chemical analysis of a black magnetic sand found in Cornwall showed the presence of 50 per cent of a white metallic oxide, upto that time unknown to chemists. He christened the element "menaccin" as the mineral was known as menaccanite. Klaproth in 1795 came across an identical oxide, an extract of a red mineral from Hungary and named the new element in the oxide as 'Titanium', after the mythological Titans—the first sons of the Earth. Only two years later, it came to be known that Klaproth and Gregor had discovered the same element.

The metal remained a laboratory curiosity for more than a century and a half. In the post-World War II era, the US aeronautic industry was in search of a light metal with good mechanical and creep resistance properties at moderately elevated temperatures. Titanium, fulfilling these prerequisites, shot into prominence and several production plants were set up in the USA. The process, as developed by W. J. Kroll, a German refugee in the US, was universally adopted and remains more or less in the original form even to date. So great was the interest in this newly available metal that the production of titanium sponge rose from a meagre 10 tonnes in 1948 to a phenomenal 17,000 tonnes in 1957 and is now around



NANA SHIVALKAR

Because of their special properties and wide industrial uses, some resources, some metals, for instance, are going to be crucial in the future. This new series will discuss such resources... titanium, silicon, beryllium, lithium, vanadium, among others.

60,000 tonnes per year

Titanium minerals

Ilmenite ($FeO.TiO_2$) and rutile (TiO_2) are the two most important minerals of titanium. Most of the world's rutile supply comes from the beach sands of New South Wales and Queensland along the east coast of Australia. Other sources include Florida in the US, India, Brazil and South Africa. Ilmenite is much more abundant than rutile and large deposits are known to exist in the US, Canada, South America, Africa and Europe, including the USSR.

But to obtain titanium from its minerals was a problem. Because titanium has such a strong affinity for oxygen that it is not possible to get the metal by the common method of reduction with carbon. Scientists had to struggle hard before they could overcome this problem (see box on p. 55), and develop a method to process the minerals.

Even so, titanium metal specimens obtained earlier still had large number of impurities. This made the the metal fragile and brittle, and unsuitable for machining. It was only when the metal was prepared in the pure state later that its extraordinary properties became evident.

When pure, titanium is a lustrous white metal. It has a low density, good strength and excellent corrosion resistance. It is ductile only when it is free from oxygen. The metal burns in air and is the only element than can burn in nitrogen.

The metal is as strong as steel but 45 per cent lighter. It is 60 per cent heavier than aluminium but twice as strong. By alloying the metal, the tensile strength can be increased from 40,000 pounds per square inch (psi) to as high as 200,000 psi. What is particularly important is that it can retain this strength even at temperatures as high as 500°C. On alloy formation, even higher temperatures do not adversely affect its strength. Titanium has also a high resistance to corrosion; in general, this can be traced to the formation of an adherent film of highly inert titanium dioxide. The resistance to corrosion in sea water is specifically due to a hydrochloride layer. A titanium plate submerged in sea water for ten years would not show even a trace of rust. Nothing would have been left behind if the plate were made of iron!

Titanium is also non-magnetic as well as a poor conductor of electricity. The electrical conductivity of copper by comparison will be 200 times higher. Consequently, titanium finds use as insulator in electrical engineering. It is also a pretty hard metal, some four-fold harder than iron and a dozen times as hard as aluminium. This is evident from its yield point which is 18 times higher than that of aluminium.

Uses

Titanium (and its alloys) finds its principal use in the aerospace industry where a high strength-weight ratio and the ability to withstand extremes of temperature are important. As a result, tanks made of titanium are found to be excellent for storing liquid oxygen or hydrogen. Its primary use is as components in the compressor section of jet engines and as structural components of air frames and space vehicle systems. Almost 90 per cent of the present world production is used by the aviation industry. A single supersonic transport jet consumes about 300 tonnes of the metal! When space technology develops to the point of having industrial installations in space, titanium would be the metal of choice. Soviet astronauts clearly demonstrated with experiments conducted in 1969 that titanium readily yields to welding and cutting in space vacuum.

The excellent resistance of the metal to sea water (chloride ion) corrosion makes it a suitable material for desalination plants and for fabrication of propeller shafts and parts of ships constantly exposed to salt water.

In the power generation section, titanium is primarily used for steam turbine blades and condenser tubing. In the chloralkali industry, titanium substrate insoluble anodes (TSIA) are preferred to graphite anodes because of

a number of advantages like longer life, low power consumption and high current efficiency. Titanium, in many ways, has a greater corrosion resistance than stainless steel; consequently, it is finding increasing use in chemical, petrochemical and food processing industries. Being physiologically inert, it can be the choice for metal implants during surgery.

When 0.1 per cent of titanium is added to steel, it greatly improves its quality. This is because titanium combines with bubbles of nitrogen and oxygen contained in molten steel. Castings made from such steel contain no cavities and are homogeneous. An interesting application based on this high affinity for nitrogen and oxygen is its use as a "getter" in vaccum systems. Last traces of air can thus be removed to produce an ultra-high vaccum of the order of 10^{-10} torr or less.

In the last few years, a very unusual property of some alloys has come to light. These alloys have a memory: they remember their former shape. One such alloy called nitinol is made from nickel and titanium. If a nitinol wire is coiled or given any intricate configuration, then heated to 150°C, cooled and stretched out onto a straight wire, it gets coiled up or assumes its initial intricate shape when heated gently to about 95°C. No definite explanation for this phenomenon has been found yet. But it can lead to very interesting applications— for example, nitinol rivets in structures that can be reached only from one side. One end of the rivet is smoothed out and passed through the hole at a low temperature. After slight warming, the rivet 'remembers' that it had a head at the end, reforms the head and fastens the components dead tight.

What is holding up a fuller utilisation is the high cost of pure titanium. Many specialised institutions are working on ways to make titanium cheaper. When a new institute of light metals was inaugurated in Cleveland, USA, the mayor, while cutting the ribbon made from titanium, was required to use a gas burner and protective glasses in place of the usual scissors!

Compounds

Among titanium compounds, the *dioxide* is obviously, the most important and widely used; it has found widespread use as a lustrous white pigment. It has replaced 'white lead'—a basic lead carbonate which has the drawback of turning black on exposure to air containing traces of hydrogen sulphide. Titanium dioxide has a high refractive index, excellent whiteness and good chemical stability. The paint gives durable films of high covering power. The high refractive index (TiO_2 2.7, white lead or zinc oxide 1.9) combined with low density (TiO_2 3.7, white lead 6.8) results in a material having highest opacity and staining power. Furthermore, unlike white lead, the dioxide is non-toxic. Heaton demonstrated this by consuming about 500 gm of titanium dioxide pigment mixed with glucose. He experienced no harmful effects but was, on the contrary, cured of an ailment which had baffled physicians for years! Titanium dioxide, therefore, finds extensive use in vitrous enamels and ceramics, in paper manufacture and for white rubber and plastic goods. *Titanium tetrachloride*, the important intermediate for the production of metal is a colourless liquid which fumes strongly in moist air and can be used as a smoke-producing compound for skywriting or for smoke screens. A soft finely divided titanium dioxide of excellent pigment properties is produced by vapour phase oxidation of titanium tetrachloride by oxygen or air at temperatures above 1000°C. Titanium tetrachloride also finds application in the petrochemical industry as a catalyst for polymerisation reactions.

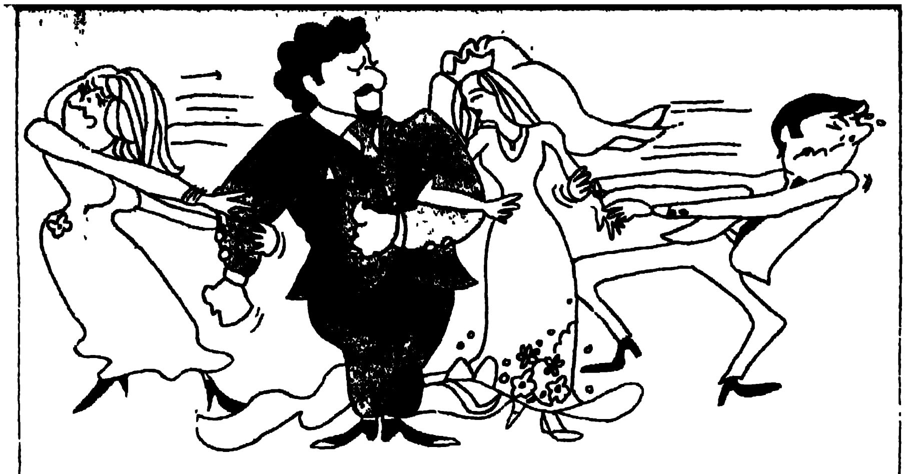
Titanium is lighter but stronger than steel

Titanium carbide can be prepared by fusing titanium oxide and silicon carbide in an electric furnace. Other methods involve heating the dioxide with carbon at about 2000°C or fusing the dioxide with calcium carbide in an electric furnace, all in an atmosphere free from oxygen and nitrogen. Titanium carbide is an extremely hard material. It has a hardness of 3,800 (Vicker's hardness scale) compared to 1,300 of tungsten carbide. Coatings of pure titanium carbide are therefore applied by vapour deposition on tools, dies, punches and components of high-speed cutting tools.

The *titanates* of alkaline earth metals, particularly barium titanate, finds applications in many high dielectric ceramic products and in piezoelectric devices. A piezoelectric crystal, when subjected to pressure, produces a vol-

Table 1: Composition of the continental and oceanic crusts

Continental crust				Oceanic crust	
Major	Percent	Trace	ppm(g/Ton)		Percent
SiO_2	61 9	Barium	425	SiO_2	49.2
Al_2O_3	15 6	Scrinnium	375	Al_2O_3	15.8
FeO	3.9	Zirconium	165	CaO	11 1
Fe_2O_3	2.6	Copper	55	FeO	7.2
CaO	5.7	Lead	12.5	MgO	8.5
MgO	3.1			Na_2O	2.7
Na_2O	3.1	Uranium	2-7	Fe_2O_3	2.2
K_2O	2.9	Mercury	0.08	TiO_2	1.4
TiO_2	0.8	Silver	0.07	K_2O	0.26
P_2O_5	0.3	Gold	0.004	MnO	0.16
MnO	0 1			P_2O_5	0.15



The union between titanium and oxygen is strong and needs a "double pull" to break it

THE 'DOUBLE PULL'

TITANIUM is found in nature mostly in the form of titanium dioxide. Titanium has a powerful affinity for oxygen and hence the union between the two is highly stable and scientists had to struggle hard to wreck this marriage. The affinity of titanium for oxygen is much stronger than that of carbon for oxygen hence the reduction of titanium dioxide by carbon according to the reaction

$$TiO_2+C \rightarrow Ti+Co_2$$

is not feasible. Therefore it becomes necessary to use another substance besides carbon which will simultaneously pull away titanium while carbon removes the oxygen. Such a substance is chlorine gas. In the Kroll process, the oxide is first converted into titanium tetrachloride by a method of 'double pull'. Chlorine is passed over a hot mixture of titanium dioxide and carbon.

$$2Cl_2+TiO_2+C \rightarrow Co_2+TiCl_4$$

The tetrachloride so obtained is reduced with molten magnesium at about 800°C in an atmosphere of argon.

$$TiCl_4+2Mg \rightarrow Ti+2MgCl_2$$

Metallic titanium is obtained as a highly porous material termed titanium sponge from which excess of magnesium and magnesium chloride are removed by volatilisation at about 1000°C. The sponge can be fused in an atmosphere of argon or helium using an electric arc and then cast into ingots.

tage across the opposite faces and vice versa. They can, therefore, be used as transducers for the interconversion of sound and electric energy.

Titanium esters formed by the reaction of $TiCl_4$ with alcohol are useful as water-proofing agents for a variety of natural and synthetic fibres. The esters hydrolyse in moist air to provide a thin transparent and adherent coating. The diacetate is used as a flame-retardant for cellulose fabrics.

The Indian scene

India is endowed with vast deposits of titanium-bearing minerals in the beach sands of Kerala, Tamil Nadu and Orissa. Conservative estimates place our reserves at 130 million tonnes of ilmenite and 7 million tonnes of rutile. Table 2 gives an analysis of Indian ilmenite and rutile.

In 1981, India produced about 1.5 lakh tonnes of ilmenite and 5,000 tonnes of rutile, respectively. When the Orissa project is fully commissioned by the middle of 1985, the Indian Rare Earths Ltd, a Government of India undertaking, would be producing 2,20,000 tonnes of ilmenite and 10,000 tonnes of rutile a year. Most of these minerals are exported yielding an export earning of about Rs. 2.5 crores.

Table 2: Analysis of Indian ilmenite and rutle (in percentage)

	Ilmenite		Rutile
	Manavalakurichi	Quilon	
TiO_2	54 42	61.08	90 06
Fe_2O_3	18 2	24 37	
FeO	22 6	9 37	0 6–1 0
V_2O_5	0 19	0.15	
SiO_2	0.24	0 6	1 2–1 9
Al_2O_3	1 29	0 4	1–3

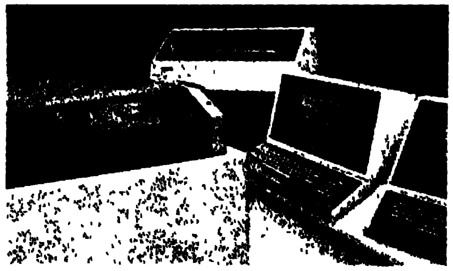
As for the world production, the USA has an annual capacity to produce 26,875 tonnes of titanium sponge, USSR 22.5 to 27.5 tonnes, Japan 13,600 tonnes and the UK, 5,250 tonnes.

In India, there is only one plant, owned and operated by Travancore Titanium Products, a Kerala Government undertaking, for the production of titanium dioxide pigment by the sulphate route. Though the licensed capacity of this plant is about 24,000 tonnes per annum, the current production is only of the order of 12,000 tonnes per year; this is enough to meet our present requirements. Another Kerala Government undertaking, Kerala Minerals and Metals Ltd, would be commissioning their high-grade titanium dioxide pigment facility based on the chloride route by the end of this year. It is expected that a production of 20,000 tonnes per year would be reached in a couple of years. Till then, our requirement of chloride-grade pigment of about 10,000 tonnes per year will have to be met by imports.

The commercial production of titanium metal is yet to commence in our country. The country's requirement of about 100 to 150 tonnes per year are again met by imports. While the export of ilmenite and rutile fetches a revenue of about Rs. 2.5 crores, import of titanium sponge costs us something between Rs. 3 and 4 crores. The technology for the production of titanium sponge has been developed on a pilot plant scale at the Nuclear Fuel Complex in Hyderabad—a constituent of the Department of Atomic Energy. A proposal for setting up a plant for the production of titanium sponge by the Defence Metallurgical Laboratory or Mishra Dhatu Nigam is under active consideration. Let us hope that the proposal will be translated into reality soon and we reap the full benefits of our abundant natural resource of this metal of the future. And in case our resources get exhausted, we can always import it from the moon!

Dr Sathe is a scientific officer in the Analytical Chemistry Division of the Bhabha Atomic Research Centre, Bombay. He also teaches analytical chemistry to post-graduate students of Bombay University and is a visiting professor at SNDT Women's University in Bombay

Next month: Silicon



You know how it is with computers
Someone offers you a set of features
Someone else offers you a few more
Or a few less

So what about those who want all these features in one system?

The Nelco System 5000

No single system offers you the almost unbelievable range of features that the Nelco System 5000 does

Compare it with the rest and see for yourself

What does the Nelco System 5000 have that the---- 101 doesn't?

The Nelco System 5000 has a dynamic memory that adjusts itself automatically to requirements of varying program sizes, unlike the ----- 101, which has fixed memory partitions

The Nelco System 5000 also has dynamic file extension, so that file capacity increases as more information is stored. File sizes in the ----- 101 are fixed and have to be declared in advance

The Nelco System 5000 also has printer spooling so multiple users don't have to wait to use a scarce resource like a printer

The ----- 101 doesn't give you this option yet

What does the Nelco System 5000 have that the-----86 doesn't?

To start with, the Nelco System 5000 controls security at four levels, eliminating unauthorised access to confidential data

And like the ----- 101, the ----- 86 doesn't have dynamic file extension

Moreover, the Nelco System 5000 offers a wide range of software, including packages for Financial Modelling, Hotels and Manufacturing Resource Planning

What does the Nelco System 5000 have that the---80 doesn't?

The Nelco System 5000 is the most growth-happy system there is, with vertical expansion for more CPU processing power and horizontal expansion to increase the number of terminals and printers. With the --- 80 you're stuck with what you get

The Nelco System 5000 allows many background jobs to be processed at a time, unlike the --- 80 which allows only one. Even the ---- 86 allows more

Further, the Nelco System 5000 as we said earlier, offers a complete range of application packages, including Word Processing

What does the Nelco System 5000 have that the---21 doesn't?

The Nelco System 5000 operates on the concept of time slicing so that a CPU bound job cannot monopolise the CPU completely, holding up all other users. On the --- 21 and the --- 80, this can and does happen

Further, again like the --- 80, the --- 21 offers very limited expandability and very little application software

What does the Nelco System 5000 have that the----------23 doesn't?

Of course, the PDP 11/23 is a very good system, even when compared to the Nelco System 5000

But on software, unlike the wide range on the Nelco System 5000, the ---------- 23, like most other systems, offers no specific packages for Financial Modelling and Manufacturing Resource Planning

And with the Nelco System 5000, you get a single-source supplier offering you a comprehensive range of support services

What does the Nelco System 5000 have that the--- -----4 doesn't?

Just about everything

So what else does the Nelco System 5000 have?

A 16-bit system based on the advanced Bit Slice Processor, with the lowest CPU cycle time

It's also the most field-upgradable and expandable system you can get vertically, with enhanced CPU power, and horizontally, with more peripherals. Plus the most extensive communication facilities, including networking.

Then it offers you Dynamic Memory. Dynamic File Extension. Printer spooling with all three options for automatic, default and no spooling. A disc sector cache in memory to save time on disc-intensive jobs. Indexed, Sequential and Contiguous file management

And more. Excellent 'housekeeping' routines. Scores of utilities. And both the commonly used data-processing languages, BASIC and COBOL

And easily the widest range of packages. Data Based Report Generator, which enables anyone to produce a report on a do-it-yourself basis. Data-based word processing. 'Qicplan' for all kinds of Financial Modelling. Advanced Program Generator to develop your own high-level programs interactively

Plus 'Solutions' a comprehensive set of application programs for all standard commercial applications like accounting, inventory control, order processing, invoicing, etc. QMRP for total Manufacturing Resource Planning. And many packages for industries like Hotels, Banking and Transport

All this, backed by a fully integrated manufacturing and R&D facility, and teams and teams of highly-trained, professional Support Groups

So if you're looking for all this in one system, here's your choice. The Nelco System 5000. Or all the other systems put together

But that would be a little expensive, wouldn't it?

In the interest of all other manufacturers, the true identities of the systems have been deliberately concealed

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ARTHRITIS

Arthritis is neither a disease of old age, nor is it a result of dietary or cultural patterns. The word arthritis merely signifies pain or swelling at the joints.

GOOD evening Doctor

Hello! Sit down what's the problem?

Doctor, I have a persistent pain in my knees and neck and a peculiar feeling of heaviness at the joints, so much so that sometimes my knees buckle under me. Today I also noticed a slight swelling in my knuckles. Do I have arthritis? I'm so worried that I will end up crippled. What should I do?

Don't worry, there is no reason to panic. What you are thinking of is rheumatoid arthritis, which is fortunately not common. Before we come to any conclusions let me make a thorough check.

But doctor, doesn't arthritis cause eventual crippling?

Firstly, I shall try to clear a few misunderstandings regarding the word arthritis itself. The term arthritis simply means pain and/or swelling of joints. Nothing more. By itself, arthritis does not indicate any disease or anything about the cause of pain and/or swelling in the joint. It simply indicates that there is a problem in the joint.

'Rheumatism' and 'gout' also involve problems at the joints don't they? How are they different from arthritis?

The terms 'rheumatism' or 'rheumatic pains' and 'gout' are often mistakenly used for arthritis. Vague aches or pains in soft tissues of the body like muscles, tendons, ligaments as well as in joints are sometimes called 'rheumatism' or 'rheumatic pains' by lay persons. Again, these words have no medical meaning nor they tell anything about the many diseases which can cause such pains.

If there are so many words to describe joint pains, how do doctors make the correct diagnosis?

Obviously, it is advisable to avoid these "pseudomedical" terms and instead, describe to the doctor the exact symptoms, like "I have pain and swelling in my knee, my joints on the fingers are stiff and swollen", rather than "I have arthritis or rheumatism".

Doctor, I thought that arthritis affects only old people...

It is a common myth that arthritis occurs only in old age. In fact, the more severe and seriously incapacitating varieties of joint diseases occur in young children and young or middle-aged adults. In contrast, the arthritis of old age (called osteoarthritis) can be considered mild and easily controllable.

Do children get the same types of arthritis as adults?

To avoid misunderstanding, I shall use the term arthritis synonymously with diseases of the joint. Children get three types of arthritis. They are traumatic arthritis or a joint disease due to injury, juvenile chronic arthritis (JCA) and rheumatic fever. These are different from the forms of arthritis affecting adults and old people.

How does one recognise these forms of arthritis in children?

In children traumatic arthritis is quite common. Inadvertant or trivial injuries which are usually forgotten by the child or ignored by the parents, may later cause joint pain and/or swelling. Usually, a single joint is involved. One must be cautious, for if the problem persists for more than two to three weeks then laboratory tests will have to be taken. Naturally, this problem is more common in persons who are always on the move as they are more prone to joint injury.

Arthritic hands (left) are thickened at the joints with bent fingers. In contrast (right) are normal hands

Another commonly seen joint disease of children is juvenile chronic arthritis (JCA) with six or seven different sub-varieties. Swelling and pain in the joints of hands and legs or sometimes in the back and hips, persisting for more than six weeks, are the usual symptoms. Children with JCA show signs of fever, loss of appetite and weight and growth retardation. Unfortunately, many doctors are not fully aware of this disease, in spite of the fact that this is the commonest cause of arthritis in children. It is important to quickly investigate, diagnose the exact sub-category and treat the disease. Unless it is done quickly, children may get deformities of the joints, their growth may be stunted and their general health may suffer. This category of arthritis is often confused with rheumatic fever, where besides symptoms like fever, etc joint pains may also occur.

I read somewhere that rheumatic fever

causes heart disease in children. How does it differ from JCA?

Rheumatic fever involves joints of the legs and hands which get affected one after another, but the involvement is fleeting in character. Fresh joints get involved while those that were painful earlier improve. This is how it differs from JCA where joint-pain persists in the same joints for weeks at a time.

Several other clinical features and pathological investigations also clearly distinguish JCA from rheumatic fever. Those having rheumatic fever require life-time treatment with penicillin to prevent the major complication — rheumatic heart disease. On the other hand, heart disease is usually not associated with other forms of arthritis Therefore, unless rheumatic fever is confirmed, there should not be any worry about heart diseases

What about arthritis in adults? What type is it likely to be?

Two major, serious and often crippling forms of arthritis occur in young adults or people in early, middle age. They are rheumatoid arthritis and seronegative spondarthritis (SSA) syndrome. Besides, young persons can also get tuberculosis of the joints.

Rheumatoid arthritis is a crippling disease, isn't it?

Rheumatoid arthritis is one of the most serious and common, chronic systemic diseases where joint involvement often leads to crippling. The exact frequency or incidence of this disease in the general population is not known

My own experience indicates that one to two per cent of the Indian population may be having this disease in some form. Fortunately, the serious form is not very common The general public considers this disease to be the real arthritis.

How can one recognise it?

It comes slowly with aching pains and morning stiffness in the small joints of fingers, hands, wrists and elbows. Knees and ankles are also often involved. Swelling of joints is common and the main feature is stiffness in the morning. Careful discussions with the patients and a good physical examination are sufficient for correct diagnosis in the early stages. Blood tests and X-rays never show up the disease in the first six months or so. Hence, there is no substitute for a good old-fashioned doctor who listens to the symptoms of the patient and examines her carefully

There are some specialists who recommend special diets to cure arthritis. Do they work?

Rheumatoid arthritis being the most severe of all the arthritis and a disease of unknown cause, self-appointed specialists are to be found galore. Most of the misinformation and misunderstandings about the so-called "arthritis" is created and dissipated by these quacks. They recommend all kinds of food restrictions and food fads, useless medicines and, above all, say that there is no cure for arthritis.

Here I would like to specifically say that the field of arthritis is an intensely clinical subject. A barrage of ill-proven investigations have no place in this speciality. And it is NOT a disease of old age. Patients should not be influenced by such quacks It is true that the exact cause of the disease is not known, but the disease is controllable and marked relief is obtained in the majority of patients.

The other type of arthritis affecting adults, is that very common?

The second type of arthritis affecting young persons is actually a group of related arthritis. About one per cent of the Indian population probably suffers from it That would mean at least seven million persons, mostly young men, who are afflicted with this disease Genetic or hereditary factors are thought to be the cause

What are the symptoms?

Pain in the lower back, difficulty in bending forward, severe stiffness in the lower back, joint involvement mainly below the waist, and pain which is worst at night and early morning are the typical features of this disease Heel pain, an eye disease called keratitis which is an inflammation of the cornea of the eye, attacks of dysentery, a burning sensation during urination, pus or blood in urine, a peculiar form of skin trouble, and sometimes fever, loss of weight and appetite are some of the features of this disease. In this disease a complete spectrum of severity is seen from the most mild form, (persistent heel pain, pain off-and-on in the knee, hip or back-pain) to a most severe and serious form of the disease called ankylosing spondylitis. The name of this disease is seronegative spondarthritis (SSA) syndrome. A lot of work has been done on this disease at the All India Institute of Medical Sciences (AIIMS)

That's interesting, what have they found?

A genetic marker called tissue type (HLA) B27 is found in a large number of patients with this disease. This is the reason why many of these patients have family members (father, uncles, brothers) having similar diseases or the same disease. It is interesting that women may have the tissue type (HLA) B27 yet they develop only a mild form of the disease. The reason for this is not clear.

You mentioned one more type of arthritis affecting adults...

Not arthritis, tuberculosis of the joints. Usually a single joint or vertebral column joints are chronically affected. In addition to pain and swelling of a single joint, loss of weight and appetite, night sweats and fever are present. If not diagnosed soon, the disease may cause permanent deformity of the joints. It is uncommon in old age. With proper care and treatment it is completely curable.

Doctor, what about joint-diseases most commonly seen with advancing age?

Osteoarthritis is a joint disease which commonly develops with advancing age. However, this disease is observed in two forms, when it develops in old age and where the disease develops secondary to any injury in the joint or other infections including gonorrheal, streptococcal and staphylococcal invasions

What secondary injuries can lead to osteoarthritis?

That's an interesting question. Trivial twisting of the knee as a youngster may lead to osteoarthritis of that knee from as early an age as 30 years. Excessive and strenuous use of a joint as seen in sportsmen and labourers may similarly lead to secondary osteoarthritis. Similarly, excessive shaking of the head by executives leads to 'neck pain' or cervical spondylitis, an another form of osteoarthritis characterised by an inflammation of a vertebra in the neck region. Coolies carrying heavy weights on their backs develop osteoarthritis of the vertebral column called the lumbar spondylitis or spondylosis. 'Cracking the knuckles' leads to osteoarthritis of small joints of hands.

Strenuous exercises or unnatural postures acquired too often and associated with weak muscles are probably the commonest causes of osteoarthritis. I dare say that some of the *yoga asanas* would quickly lead to osteoarthritis in these persons. Thus, sitting crosslegged, or squatting as during the use of an 'Indian style' lavatory leads to early osteoarthritis starting at 35 or 40 years of age. Few realise as to how much weight we exert on our shoulders while sleeping on our sides. Almost the entire weight of our upper body compresses the shoulders. No wonder the shoulder is a common site of osteoarthritis. Osteoarthritis acquires different names when it afflicts different joints. Thus it is cervical spondylosis when it is in the neck, lumbar spondylosis when in the lower back, and elsewhere it remains osteoarthritis of so-and-so joint. Most people think that osteoarthritis involves only one or at the most only a few joints. This is not true. Generalised, primary osteoarthritis is a disease of multiple joints and superficially resembles rheumatoid arthritis.

What are the symptoms of osteoarthritis?

The important joints involved include the knees, neck, back, small joints in fingers, joint at the floor of the "snuffbox" and shoulders. Also, joints involved in past injuries are usually a site for osteoarthritis at a later time. The disease is predominantly asymmetrical, joints on both the sides of the body are not involved together or not to the same extent. There is no morning stiffness.

The first movement after sitting in a particular posture is very painful and a little movement "opens up the joints". Prominent cracking sounds can be heard during movement of the joint, some times so loud as to be embarrassing. A peculiar feeling of heaviness in the joint is also present. Sometimes the joints seem to fail to bear the body weight, and a patient may complain about "the knee buckling under me". The disease is localised to the joints and there is no systemic illness, no fever, no weight-loss. A simple blood test like ESR (erythrocyte sedimentation test) is normal. X rays show typical changes and here diagnosis is easy and straight forward.

Are there some common guide-lines in the treatment of all joint diseases?

The neck collar is usually used for painful neck injuries or cervical spondylitis. The principle employed is the same as that applied in splinting

Well, broadly speaking yes. There are three aspects to the management of joint-diseases. Firstly, the pain, stiffness and other related symptoms must be controlled. Secondly, joint function must be maintained and thirdly, the root cause, if known, must be eliminated. Thus all the joint diseases which are due to inflammatory conditions would require anti-inflammatory drugs and not simple pain killers. Aspirin, is the best known medicine in this group.

Aspirin! I thought it was a simple pain killer.

It is unfortunately often labelled a simple pain killer. This is wrong. In addition to its pain-killing property, it has a strong anti-inflammatory property at higher doses. Those who cannot tolerate higher doses and have money to buy more expensive drugs, can go for fancy aspirin-like drugs like naproxen, etc. If used properly aspirin is harmless. The common misbelief that it causes heart diseases can be totally ignored. Actually, aspirin is extensively used for preventing heart attacks.

We were talking about treatment for osteoarthritis

It is amazing that so many people suffer from this disease when the treatment is so simple. Basically this disease is caused by weakness of muscles and laxness of tendons and ligaments. Therefore, the ONLY effective treatment of osteoarthritis is proper muscle-tone building exercises. No amount of any medicine would affect osteoarthritis. In fact in this disease, most of the medicines act as simple pain killers. As soon as their effect wanes the pain returns.

Why is it that in spite of this simple treatment of muscle tone building exercises for osteoarthritis people keep suffering?

The reason is simple. Most of them are not aware of the facts. Even if some of them are, they do not get proper advice on the type of exercises to do. Last but not least, exercise for the building of the muscle-tone causes exacerbation of pain in the beginning. It becomes unbearable and most patients discontinue the exercises. Over-weight or obesity with no will to control it, especially in elderly women and habitual wrong postures further aggravate the problem. But probably the most important of all factors is the wrong idea and negative attitude that there is nothing which can be done about it, so why bother.

You say that the pain becomes unbearable during exercise. Is there no way to alleviate it?

If the pain gets exacerbated after exercise there is a simple remedy. Wrap an ice pack (crushed ice wrapped in a towel) around the joint for 10 to 15 minutes, prior to the start of exercise and take two tablets of any simple pain killer like aspirin or paracetamol. This can then be followed by real workup exercises mostly of the isometric contraction type. This simple procedure will immediately solve the problem of exaggeration of pain on exercise, and the problem gets under full control in three-to-four months. No amount of any 'magic medicine' will ever give relief in osteoarthritis except muscle-tone building exercises. Of course, correct diagnosis is essential.

Does physiotherapy help?

For keeping the joints in a proper functional condition and the muscle-tone in normal condition, intensive physiotherapy is important. Splinting and simple advice on postures is also essential. If not done, the patient may be "cured" but becomes a cripple with deformed joints.

What is splinting? Is it related in any way to the 'collars' and 'belts' that arthritic patients sometimes wear?

Splinting is a process by which the bones are bound along pieces of supportive material like strips of wood or metal, encased in cloth and padding. Just as broken bones heal best when wrapped in a supportive cast, arthritic patients feel some relief when

splints are used. The purpose of splinting is to help maintain a correct posture The collars and belts used by arthritis patients are really sophisticated splints, specially designed to correct cervical and lumbar spondylitis.

Doctor, where the root cause of arthritis is not known, what line of treatment is usually followed?

Some empirical forms of treatment have been quite effective The best known among these are gold-thiols, D penicillamine and chloroquine for rheumatoid arthritis, some drugs like methotrexate for psoriatic arthritis and colchicine for an acute attack of a rare disease, gout Recently, D-penicillamine and new understanding on the old medicine gold-thiol, has revolutionised the therapy of rheumatoid arthritis It gives a lie to the commonly heard phrase among the lay-public that there is no treatment for arthritis in scientific medicine .

I read a news item where cortisone has proved to be a magic cure' for arthritis What is your opinion?

Cortisone, a steroid hormone, and its other preparations are thought to bring about a dramatic cure overnight Patients get highly impressed and want to continue with them for a life time. But cortisone-type drugs do not control the disease but only "hide it under the rug'. Patients become psychologically dependent on these drugs leading to major and serious complications. This treatment spoils the case completely and makes the patient resistant and reluctant to take the correct treatment Do not take oral cortisone preparations for arthritis even it prescribed by your doctor However, local cortisone injections once in a while could be very useful for some conditions

Do not rush to the doctor with the latest press report' of a magic cure of arthritis Stick to the correct scientific programme of management. You will feel the benefit in the long run

Is arthritis connected in any way with strokes or paralysis?

A problem often faced by me has been the misunderstanding among the family members of patients that arthritis leads to a stroke or paralysis. Due to the severe involvement of the joints and pain, some patients may be reluctant to move their hands or feet and thus become more immobile. This is wrongly taken as paralysis

And doctor, is there any need for diet restriction in arthritis?

Due to our strong social background of 'traditional indigenous medicine' a number of diet-related fads have become an almost an integral part of arthritis. None of the common joint diseases have anything to do with the type of diet. Patients must take a normal,balanced, nourishing diet with adequate amounts of vitamins and minerals. All varieties of food restrictions so widely "prescribed" (sometimes even by physicians), have no scientific basis. But, care should be taken about calorie-rich food items to prevent overweight.

As I was telling, arthritis is in no way related to food habits. But about cultural habits one cannot be so sure. Perhaps using Indian-style toilets does aggravate the disease but since there are no studies on the relationship between Indian cultural habits and arthritis, one cannot make a categorical statement

A. N. Malaviya

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from p. 34

What's so distinct about *mutton do piazza* or *mutton masala* made at a local *dhaba* or in a road-side cafe? These and other dishes have a distinct meaty flavour but the chemical reactions involved therein are poorly understood Science tells us that flavour is dependent on many variables like acidity types of chemicals (spices) used, their concentration, cooking temperature, and the time and degree of moisture present, to name a few That is why the same meat cooked by different methods (roasting, stewing) tastes different.

In general, all meats contain two types of tissues, muscle fibres and connective tissue. Muscle fibres are most concentrated in the red portions of the meat. Connective tissue comprises the white portion of the meat surrounding the muscles. Meat with a high proportion of muscle fibre is generally quite tender when raw but tends to dehydrate and toughen on cooking. Cuts with a high connective tissue composition are tenderised by cooking but are very tough in the raw state so both types must be cooked accordingly

Recent research indicates that long time, low temperature (250 F or 90 to 120°C) cooking is best, as it prolongs the lifetimes of natural meat enzymes that break down proteins and so assists the tenderising process This is also true of certain *dals* (whole *udad*), which traditionally were cooked on a low, simmering flame for a whole day Adequate cooking is essential not only to enhance taste but also to kill the bacteria present in the meat

Marinating, or soaking tough meat in a vinegar solution with flavouring agents like herbs or *masalas* before cooking tenderises meat further. The acid attacks the coarse raw meat fibres, breaking them down before cooking and allowing the flavourings to penetrate.

Spices are used to enhance the flavour of food. They are also used to mask the taste of spoiling food that is still nutritious, but if unspiced would have to be thrown away. Some spices are used as preservatives, that enable people to preserve meat for a year or more, without refrigeration Cloves, for example, contain a chemical called eugenol that inhibits the growth of bacteria Spices are also known to have therapeutic value. There are also other fairly complex scientific processes that cooks take in their stride, like controlling the precise amount of acidity when making sugar syrups, *hal was*, jams and marmalades. Only when the correct point is reached in the boiling of the partially inverting sugar and other ingredients, can the cooking process be stopped and the result allowed to cool into its new form.

When a fruit is cooked, say for jams and *murambas*, there is a marked flavour improvement. This is due to proper blending of sugars and starches with the acids in the fruits.

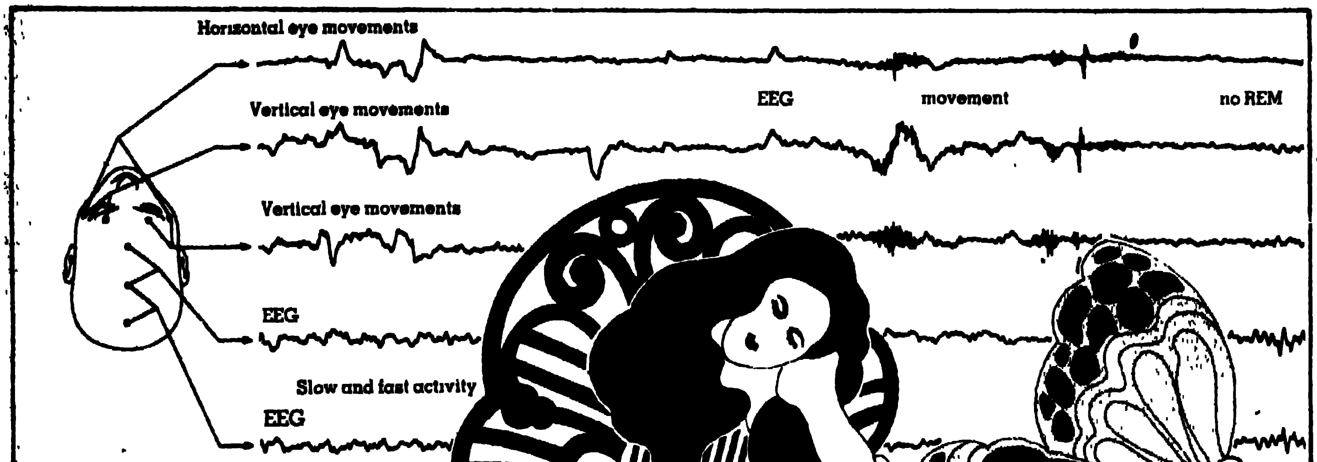
David Gunston

Mr. Gunston is a freelance writer who resides in Portsmouth, England

Nobel laureate Francis Crick and Graeme Mitchison unravel the secret of dreams occurring during REM sleep in a daring new hypothesis

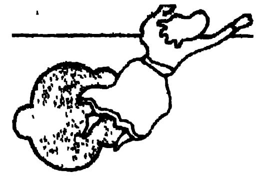
DREAMS

Suresh Kanekar



SCIENTISTS have hardly begun to understand the stuff dreams are made of. Dreams present a very elusive and difficult area of scientific research. They have been studied in their mythological, psychological, and neurophysiological aspects. The three approaches roughly represent an historical sequence, at least in emphasis, in the study of dreams and it is the latest, the neurophysiological approach, that is likely to answer some of the important questions that arise with respect to dreaming behaviour.

The neurophysiologists unearthed their first important clue to dreaming behaviour while monitoring the electrical activity of the brain (EEG). Observers found that the sleeping brain displayed two dominant modes—one of deep relaxed sleep and the other of light sleep where the EEG resembled the rhythms of drowsy wakefulness except that there was a profound reduction of muscle tone accompanied by darting movements of the eyeballs (rapid eye movement or REM). The high level brain activity in this cycle during the second mode (REM sleep) seemed to suggest that the closed (but moving) eyes were "looking" (or dreaming) while the body acted as if paralysed. Thus it was in 1953 that Aserinsky and Kleitman reported an association between rapid eye movements (REM) and dreaming, a finding which was confirmed by subsequent research and has



stimulated a vast amount of neurophysiological investigation with or without theoretical underpinning. We now know that periods of REM sleep alternate with periods of non-REM sleep which has roughly four stages of increasing depth of sleep. REM sleep has been reported for all viviparous mammals so far studied, such as monkeys, dogs, cats, rats, elephants, and even primitive marsupials like the opossum.

A human adult may have, during one night, 1½ to 2 hours of REM sleep

spread over several periods. Dreams reported during REM sleep are very much more frequent than dreams reported during non-REM sleep; the former dreams are typically vivid hallucinoid, and illogical, while the latter have a thought-like character. Apparently, most of the dreams during REM sleep fail to reach normal consciousness. One significant observation is that newborn human babies have a long time, upto eight hours, of REM sleep per day and REM sleep appears to be even more frequent for a foetus in the womb, especially in the third trimester. This observation holds for other mammals too. If an animal is deprived of REM sleep but allowed to have non-REM sleep, it will usually compensate by having more REM sleep in subsequent sleeping periods.

What exactly is the function of REM sleep? According to Roffwarg, Muzio, and Dement's theory, REM sleep provides the internal stimulation required for structural differentiation and maturation of the central nervous system during foetal and neonatal life when brain growth is maximal. Snyder's theory proposes that REM sleep first evolved in the mammal to serve a "sentinel" or vigilance function needed for survival from attack by predators. The homeostatic theory of Ephron and Carrington suggests the existence of a homeostatic interplay between REM sleep and non-REM sleep to account for the sequential relationship found between these two sleep states. (Homeostasis is the tendency of the organism to achieve equilibrium between interdependent elements and systems.) According to Berger's oculomotor innervation hypothesis, REM sleep provides a mechanism for establishing neuromuscular pathways involved in voluntary conjugate eye movements. However, none of these and other theories can satisfactorily account for all the available findings on REM sleep.

Recently, in collaboration with Graeme Mitchison, Francis Crick, who won the Nobel Prize for discovering the structure of the DNA molecule, has come up with an intriguing hypothesis regarding the function of REM sleep. Crick and Mitchison, in *Nature* of 14 July 1983, propose that the function of REM sleep is to eliminate undesirable modes of interaction in networks of cells in the cerebral cortex.

Different areas of the cerebral cortex are associated with different functions such as vision and touch. The neocortex is evolved only in mammals, apparently for special, higher functions like reasoning and problem-solving. The neocortex is richly endowed with neural interconnections and a vital function of these could be to store and reproduce associations. An "event", say like an evening at the opera, consists of thousands of sensations, impressions and memories, each of which may be represented by the activity of a subset of cells in a cell assembly. All the cells involved in that "event", such as the evening at the opera with a lady wearing a rose, may form mutual synapses. Later the fragrance of a rose is enough to trigger off the memories of that entire evening. It is also hypothesised that information is not

"One should not be encouraged to recall one's dreams because this may help retain patterns of thought that need to be eliminated..."

concentrated but *distributed* over many synapses. A synapse involved in the above mentioned rosy aura could be superimposed with information regarding a cricket match. Such information is also robust, that is to say, the addition or removal of a few synapses does not affect it.

Crick and Mitchison suggest that because of super-imposition, such networks of cells could become overloaded with simultaneous storage of too many different patterns or associations of patterns, especially if there is too large an overlap among the stored patterns. Depending on the exact structure of the net, this overload can precipitate certain patterns of behaviour such as fantasy, obsession, and hallucination. For instance, when the net produces far-fetched or bizarre associations, you have fantasy (wings and horses may combine to give you a Pegasus). We may speak of obsession if the net produces the same or similar state, whatever the input (That is, whatever the signals, a recurring an image of a "sexy" female is evoked.) Some nets, especially those which feed back on themselves, may respond to inappropriate input signals and cause hallucinations. Such modes of activity in cortical nets are normally undesirable, and are referred to as parasitic modes by Crick and Mitchison.

There is some evidence for specificity in the cortical wiring But the exact locations and the interconnections between the neurons are brought about in a semi-random manner. These are also reinforced and refined through learning or experience. This makes us "flexible". Otherwise the organism would not be able to profit from novel information. Thus the very process which allows learning and cortical growth may lead to undesirable parasitic modes (a little like "wrong" connections in electric circuitry).

How to get rid of these snarls and "short-circuiting" connections? Crick and Mitchison suggest that to achieve that aim the major inputs and outputs of the system must be turned off; sleep isolates the system. Then there is dreaming which involves the activation of random connections internally. A fallout of such behaviour is that it also activates potentially parasitic modes in the cortical network REM sleep, as theorised by Crick and Mitchison, provides the mechanism to damp down the parasitic modes.

During REM sleep, the forebrain is periodically and widely stimulated by the brain stem. The available evidence suggests that in REM sleep, the brain is isolated from its normal input and output channels and its intense activity is promoted by nonspecific signals from the brain stem. Thus *every night* we dream, whether we remember our dreams or not But if the "parasitic" modes are wiped out how do we recall them in our waking state? For instance, if the Pegasus is resurrected and banished forever in our sleep, why do we remember his flight when we awake? The answer simply is: you might awake due to physical or psychological discomfort during a dream and thus you come to remember the dream. Otherwise, as Crick and Mitchison suggest, in REM sleep we unlearn our unconscious dreams. "We dream in order to forget."

As Crick and Mitchison very clearly admit, their theory is speculative and cannot account for all the available data. On the other hand, it appears to offer a better explanation of the present psychological and neurophysiological evidence than any other theory of REM sleep. Not only does it explain the need of REM sleep in adult life, but it also accounts for the excessive REM sleep during the development of the brain before and after birth. The theory is also consistent with the bizarre and hallucinoid nature of REM dreams. It cannot satisfactorily explain as of now the effects of REM sleep deprivation. If the Crick-Mitchison hypothesis is right, such a subject, deprived of his tuning process provided by REM sleep, should be overwhelmed by the undesirable parasitic modes and should eventually land up in the lunatic asylum! One major problem is that a direct test of the theory does not appear to be feasible at the current stage of neurophysiological research. Indirect evidence can of course be gathered and the theory will probably stimulate some novel approaches to the study of REM sleep and related matters.

One important and practical conclusion from Crick and Mitchison's theory is that one should not be encouraged to try to recall one's dreams because this may help to retain patterns of thought which need to be eliminated for a more effective cortical functioning. John Hughlings Jackson, the pioneer English neurologist, had observed: "Find out all about dreams and you will have found out all about insanity." Crick and Mitchison's hypothesis reveals the prophetic aspect of this statement, though not in the manner anticipated by Jackson □

NEURONS are the basic units of the nervous system. Each neuron consists of a cell body and thread-like branches called the *dendrites*. These pick up the messages and pass them into the cell body from where they are analysed and sent to the *axon* —a single, long terminal—which connects the neuron to the dendrites of the next neuron. This connection however is not a physical but a chemical one. A gap called *synapse* separates the point of contact between one nerve cell and the next.

Inside the neurons are potassium ions while outside its membrane are sodium ions. When an impulse arrives there is an exchange of ions and generation of electrical potential which travels down the axon to the synapse. At this junction neurochemicals such as acetylcholine or noradrenalin are released which bind to the receptor sites on the other neuron and thus transmit the message.

Some of the electrical activity of the neurons can be picked up by electrodes attached to the scalp. Despite the amazingly complex activity of the brain, the electrical rhythms thus detected are surprisingly simple.

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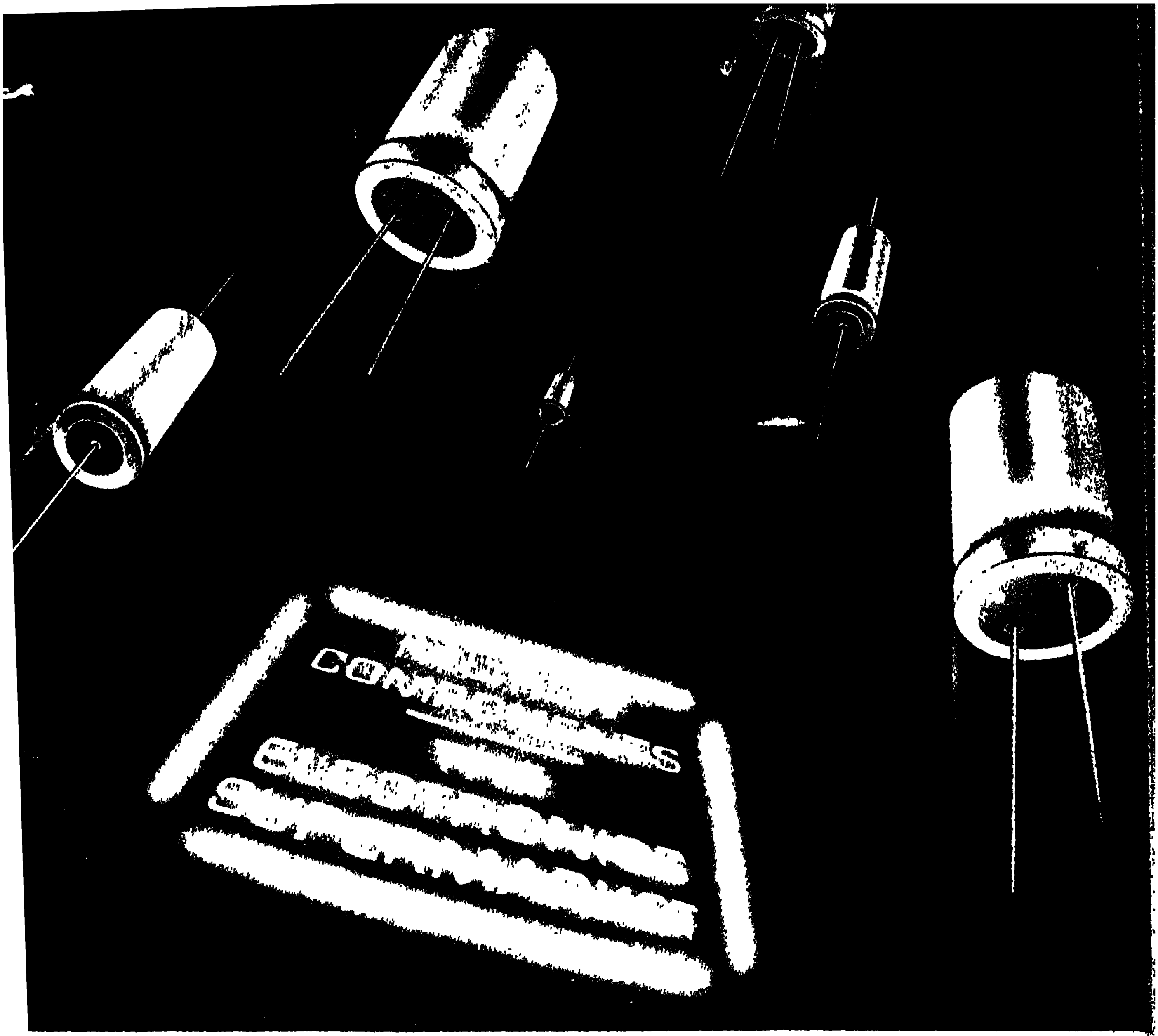

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THE PENICILLIN PAPERS

IN Central Asia, the cradle of civilisation, for centuries nature healers tramped from one village to the next, selling age-old remedies for skin diseases. One of their most famous concoctions was a paste made from barley sugar and dried apples. These ingredients were chewed by the healer himself, mixed with his saliva, and left overnight in a damp place. After the mixture became covered with a yellow-green velvety growth, it was applied to skin sores as poultices. The growth was none other than the mould, *Penicillium*.

The story of penicillin as a common therapeutic tool is a more recent one. It began in Britain, in the laboratory of St Mary's Hospital, Paddington, in the 1920s.

The laboratory was a mess, strewn with burners, glassware, half-filled test tubes, cotton plugs and dusty flasks partially filled with various coloured solutions, awaiting microscopic inspection. In the midst of the clutter, a bespectacled bacteriologist chatted to his assistant. A routine day, in an ordinary laboratory, or so it seemed. In the course of his inspection of the myriad bacterial colonies on miscellaneous petri dishes, the researcher chanced upon something unusual on a bacterial culture of *Staphylococci*. These are generally pathogenic (disease producing) bacteria that cause a number of infections including pneumonia, food poisoning and festering wounds. The culture plate showed a fungal contaminant, a tiresome occurrence in every laboratory. On closer examination it appeared that the fungal colony had secreted around its edges 'something' that dissolved the yellow clumps of *Staphylococci*. The something turned out to be a wonder drug that revolutionised medicine, the antibiotic penicillin.

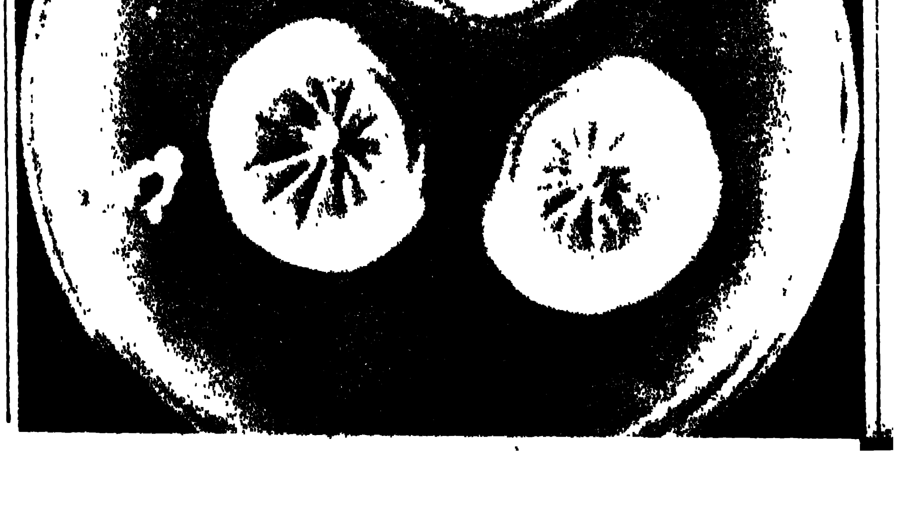
On that September day in 1928 when Alexander Fleming scooped out the fungus into a test-tube for subsequent cultivation he did not fully realise the potential of his discovery. He did not even know the name of the fungus he had isolated, but he did know that he was on the brink of something important.

Born at Lochfield in Scotland on 6 August, 1881 Alexander Fleming was the seventh of eight children. Much of his boyhood was spent in the Scottish Highlands climbing trees, stalking rabbits, playing football and swimming in country streams. It was a time during which he learnt to use his eyes and his head, and hold his tongue, invaluable experience for a researcher. Later he worked as a clerk in a shipping company in London, and took part in the Boer War, in South Africa. A legacy from his uncle enabled him to enroll in medical school. He graduated at the top of his class in 1901 and became a fellow of the Royal College of Surgeons. Later he was accepted (as a researcher) by Almroth Wright, an eminent pathologist at St Mary's Hospital in Paddington. He remained there for life.

In 1928, there was no method of killing bacteria except by acids and disinfectants which would finish off the patient as well. When Fleming found that his new discovery could kill certain disease-causing organ

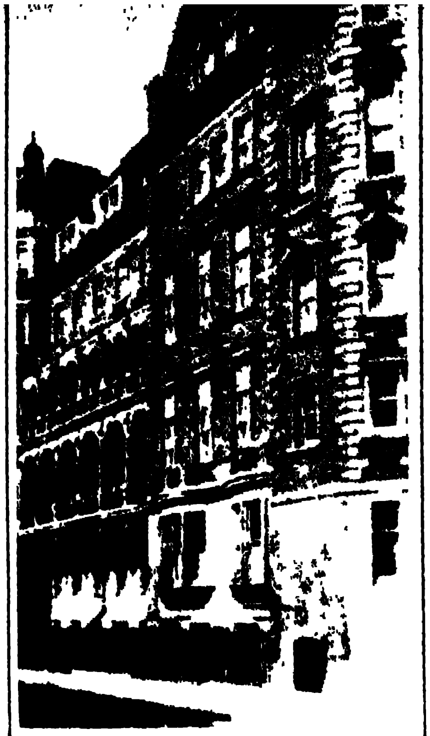
Alexander Fleming in his laboratory

A close up of the fungus **Penicillin**



isms, he thought that it would be of value in treating infections. To assess this compound in the laboratory, Fleming invented a piece of apparatus—a home-made device of which he was very proud. He used it on every possible occasion. It consisted of two microscope slides, separated by vaselined strips of paper to make four very thin cells. Into these, he inserted mixtures of human defibrinated blood (blood from which the protein fibrin has been removed so that it cannot clot), a suitable dilution of a broth culture of organisms (usually *Staphylococci*) and dilutions of the substance being tested. After sealing with wax, the slides were incubated overnight at 37°C, to allow surviving organisms to grow into colonies which could be counted using a lens. Few colonies formed, confirming that the compound secreted by the contaminant mould could kill disease-causing bacteria. Fleming then grew the mould on different liquid media. Once the mould had grown to maturity, he strained the solution to obtain a clear fluid. He found that the fluid lost its power to destroy bacteria within a few days of its extraction. This fluid was tested in laboratory animals with no ill effects. The next step was to use it to treat human beings for whom it proved to be non-toxic as well. To confirm the non-toxicity of the fungal extract, Fleming extracted the yellow liquid from the fungal contaminant and drank half a glass of it himself—again with no harmful effects. This convinced him that the fungus needed further investigation. His colleague Charles La Touche, a specialist in the study of fungi and moulds identified the contaminant as *Penicillium notatum*.

Since the yellow compound was readily deactivated, the logical step was to find a means of stabilising it for storage and further use. Bacteriologists in the twenties had a sketchy knowledge of chemistry and Fleming was no exception to the rule. So the concentration of the yellow solution was entrusted to a young ophthalmologist Fredrick Ridley. Working with Stuart Craddock, a research scholar, Ridley proceeded to test the solution. They evaporated it at a low temperature (40°C) till only a few millilitres of red fluid or sticky mass remained. To this they added various organic solvents including alcohol and ether and then measured the amount of penicillin that dissolved in each solvent. Their notes indicate that penicillin readily solubilised in these liquids and there was nothing to suggest that its instability was a problem. What should have been a third



St. Mary's Hospital, Paddington—the scene of Fleming's discovery

step in the investigation, is the transfer of penicillin to a watery base. Had Fleming's knowledge of chemistry been sounder, he would have attempted it. But he had a hazy idea of chemistry, and very little interest in it. As a result he failed to report the details of Ridley's work. He went so far as to state in one of his papers, that "it (penicillin) was insoluble in ether and chloroform" when chloroform was not even tried out!

In later tests, penicillin was intravenously injected into the blood stream of rabbits, to test its action on them. It was rapidly inactivated soon after the injection. This led Fleming to dismiss it as nothing more than a local agent to treat surface infections. He omitted even the mention of it in a paper he published in 1931, entitled 'Indications for and the value of intravenous germicides'. Thus penicillin was consigned to oblivion a few years after its discovery—an episode which underlines rather strongly the need for an interdisciplinary approach to scientific knowledge.

In the autumn of 1942 when Alexander Fleming attained celebrity status, he was questioned as to why he let penicillin remain neglected for 12 years after its discovery. His reply never varied, he wanted to use it to treat infected patients, but his clinical colleagues failed to use it on the patients. Even if they did so, all the penicillin he possessed had generally become inert because of its instability. Finally, attempts in his own laboratory to produce a more concentrated solution for the purpose had failed.

In the words of Gwyn Macfarlane, Fleming was "a man who stumbles on a nugget of gold, shows it to a few friends and then goes off to look for some thing else". It took Howard Florey, "a man who goes back to the same spot and creates a gold mine," to recognise the value of penicillin and to study it further. The most important factor in Florey's success as a scientist was his sense of direction in his research. His flair for choosing lines that led not into blind alleys but into wider and wider fields, has been described as 'almost uncanny". He was essentially an experimentalist.

It is he who invented the 'Oxford Unit", a special measure to assess the quantity of penicillin in a given solution. This unit, named after his laboratory in Oxford, simplified the study of penicillin considerably. In collaboration with Ernest Boris Chain, a German scientist, Florey developed the idea of penicillin as an antibiotic, and gave it to the world. World War II, gave the fight against infection top priority. Florey, along with Chain, tried to isolate the actual antibacterial agent from the mould studied by Fleming. Rather quickly, they obtained a yellow powder from the mouldy broth that contained the agent. The war lent urgency to the need for preparing purer samples of penicillin. Several laboratories in the US and Great Britain intensified their research in this area.

In 1943, a young woman was specially employed by the Northern Regional Research Laboratory in Peoria, Illinois. She had to go round the markets looking for rotten fruit. She was called "Mouldy Mary". One day she brought back a cantaloup melon covered with a remarkably productive mould *Penicillium chrysogenum*. Almost all the penicillin used today has descended from that one rotten melon bought at the market in Peoria. By 1944, American chemical plants could produce Oxford Units of penicillin that reached the thousands of millions mark. Better and newer methods for bulk production were devised. Soon penicillin became an important medical workhorse, rather overworked as more recent studies seem to indicate.

Fleming, Florey and Chain were knighted for their work in 1944 and in 1945 they were joint recipients of the Nobel Prize for Medicine and Physiology. Penicillin itself was already widely used.

Gillian Valladares

Ms Valladares has an M.Sc. in Life Sciences from the University of Bombay.

OF BOSE AND BOWMAN

MOST people know Archimedes by his ecstatic exclamation "Eureka!" But did you know that Archimedes was also a good defence scientist and that there is screw named after him? Similarly, Newton for most of us is associated with the falling apple and the law of gravitation. But besides inventing the calculus (which Leibnitz also did), Isaac Newton was also a pioneer researcher in Optics (and an occultist, too). Naturally, these giants are immortalised in the annals of science: they are named in laws and phenomena that they were associated with. Given below are ten examples. Can you spot the correct one? Answers on pages 74, 75

(1) Chandrasekhar Limit
- (A) Limit of the expanding universe.
- (B) A limit beyond which a star suffers internal collapse
- (C) Limit to which a giant star would grow

(2) Bose Particle
- (A) A part of the stigma in flowers.
- (B) Smallest particle in the universe.
- (C) A type of elementary particle.

(3) Newton's Rings
- (A) Rings around Saturn
- (B) Interference fringes formed by thin films
- (C) Orbits of circular motion

(4) Islet of Langerhans
- (A) Cells in the pancreas producing insulin.
- (B) Sclera or white portion of the eye
- (C) An island emerging as a result of an earthquake.

(5) Bowman's Capsule
- (A) A capsule that dissolves in human digestive juices..
- (B) An implantable inert capsule for delayed drug delivery
- (C) A part of the kidney responsible for filtering blood.

(6) van der Waals' Force
- (A) Long range forces of attraction between molecules
- (B) Force needed to separate two halves of a sphere.
- (C) Surface tension at the walls of a container of liquid.

(7) Van Allen Belt
- (A) Orthopaedic belt to provide support
- (B) A girdle of intense ionizing radiation.
- (C) The stretch of aluminium deposits

(8) Lissajous Figures
- (A) A statistical series
- (B) A set of irrational numbers
- (C) A pattern traced by two superimposed vibrations

(9) Archimede s' Screw
- (A) An instrument to measure density.
- (B) An ancient implement to lift water.
- (C) A floating valve

(10) Petri 'dish
- (A) A dish used for evaporation and crystallisation.
- (B) Dish used for bacterial culture
- (C) Disc like antenna of a radio telescope

Blackouts

Continued from p. 31

facilities which were damaged. Today this process relies heavily on the experience and judgement of the engineering personnel and there is only preliminary work done to suggest ways and means to restore the system to normal in the minimum time.

Power networks of neighbouring areas, for instance, different states are invariably interconnected to form a grid, the primary purpose being to help a neighbour, when it is deficient in power generation. The consequences of such interconnections must be closely examined in the context of shortage of power generation almost everywhere in the country. Coordination under these conditions assumes much greater significance here than in other countries where the power position is not so critical. There are two schools of thought --one favours strong or firm interconnections between areas and the other advocates loose linkages which can be cut off quickly during an emergency. However, both schools subscribe to the philosophy that "when a man is drowning his associates must jump in to save him" upto a point where "the drowning man threatens to pull his rescuer under", at this point, each system (area) must be isolated for individual survival. An interesting possibility exists of interconnecting state grids by direct current (DC) links which enables different regions to operate at different frequencies, unlike when the system works on AC. This technology has not yet been tried in India, though it is being practised elsewhere.

The coordinated operation of a large power system is quite an involved task and requires efficient equipment and

equally efficient policy-making and operating personnel. Power failures can be caused by malfunction of equipment and or defective operating procedures. While the former can probably be set right technically, the latter is more difficult to deal with. It calls for integrity of all those who are concerned with system operation to enable them to assess and impress upon others the gravity of the decisions made by them. We are yet to get satisfactory answers to our queries as to why our system operates at 49 Hz most of the time, and as to why our load-shedding relays do not swing into action even during emergency conditions!

Dr Vanrandkar is Professor of Electrical Engineering in the Victoria Jubilee Technical Institute, Bombay. He has a Ph D in electrical engineering from I I T, Kanpur. He is co author of a book Power System Analysis, Operation and Automation *(in press)*

Mr Sunthankar is a faculty member in the electrical engineering department in the Institute. He has been for long associated with testing of electric machinery

OVER-TEMPERATURE ALARM

THIS is a solid-state device which gives an audio alarm whenever the temperature exceeds a certain fixed limit. The device can be used to monitor car engine temperature or in any other similar application. The device works with 12-volt DC power supply or with any car having 12-volt battery with positive or negative ground system.

The circuit of the device requires a thermistor, two ICs and a few other components. All the components are cheap and readily available. The circuit is very simple and can be easily attached to the "LED engine temperature indicator" (SCIENCE TODAY, September 1983).

The thermistor (an abbreviation for "thermally sensitive resistor") is primarily a resistive element but is quite different from an ordinary resistor. The characteristic of the thermistor is that there is considerable reduction in its resistance with a small increase in the temperature. As a rule of thumb, the value of the thermistor drops by 50 per cent for every 20°C temperature increase.

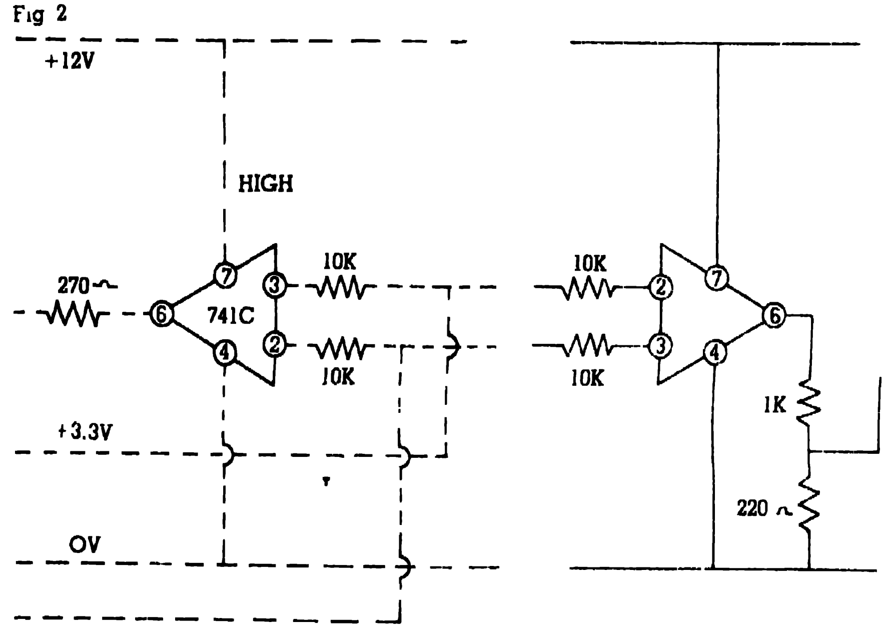
The thermistor is connected to the 6.2 V zener-regulated supply through the 3.9 K resistor. This series network provides the voltage divider action. Thus, as the temperature sensed by the thermistor increases, the fall in its resistance develops proportionately, increasing the voltage across the 3.9 K resistor.

The first IC 741C is used here as the voltage comparator. The 1 K preset potentiometer provides adjustable reference voltage against which the voltage developed across the 3.9 K resistor is compared.

Whenever the temperature sensed by the thermistor increases there is a drop in thermistor resistance and corresponding increase in the voltage drop across the 3.9 K resistor. This increasing voltage drop will make the non-inverting input terminal of the IC positive in comparison with its inverting input terminal, and drive the output of the IC to high level. This will raise the potential at the preset terminal of the IC 555 from almost zero to more than 2 volts. As the IC 555 is connected as the astable multivibrator with a frequency of about 1500 Hz, the repetitive high- and low-going output provided by this stage will drive the loudspeaker-driving transistor and the loudspeaker will produce an audio alarm.

The thermistor can be housed in a suitable brass housing or probe. Take sufficient care, for the thermistor is very

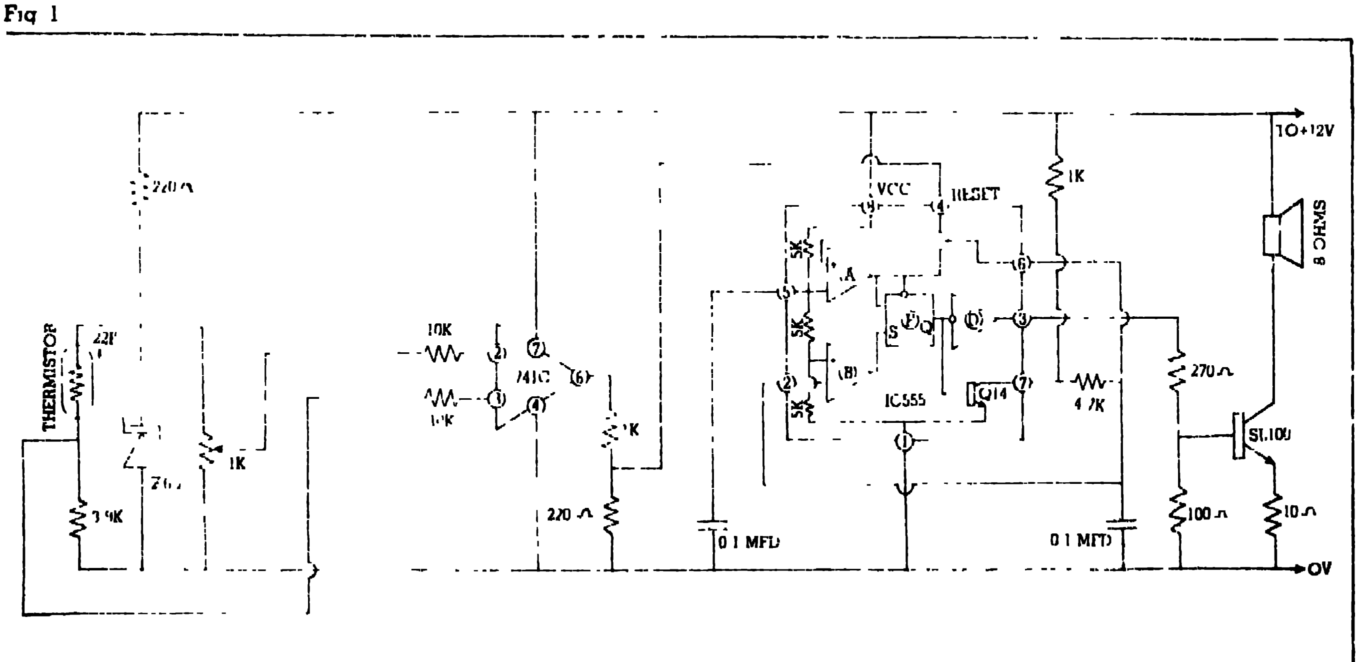
Fig 2



THE HIGH SENSING PART OF LED ENGINE TEMPERATURE INDICATOR CIRCUIT

VOLTAGE COMPARATOR STAGE OF THE "OVER TEMPERATURE ALARM" CIRCUIT

Fig 1



"The device can be used to monitor car engine temperature or in any other similar application"

THERMISTOR	R
10K	1.8K
15K	2.7K
22K	3.9K
33K	5.6K
47K	8.2K

fragile Make sure that both the thermistor leads are electrically isolated from the brass housing or probe.

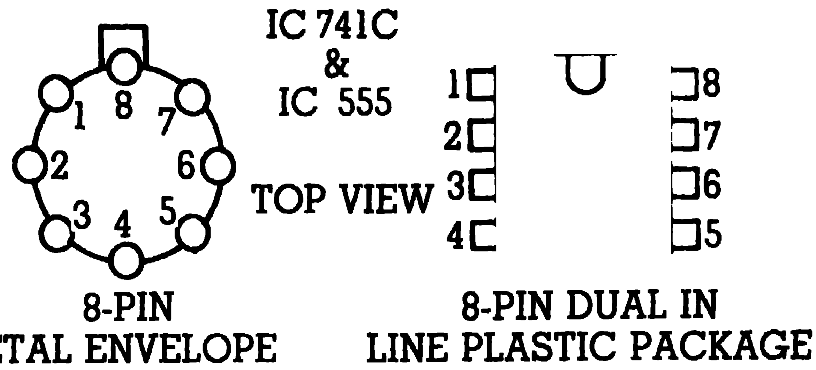
Normally, the thermistor value is its resistance value at room temperature, that is, 30°C. The indicator uses the thermistor of 22 K ohms at 30°C You may use any other value from 10 K to 47 K ohms. The chart given below indicates the necessary change in the value of the 3.9 K resistor to suit the thermistor

Calibration

When the construction of the device is complete, connect it with proper polarity to a DC 12 V supply Insert the thermistor in a suitable metallic probe and dip it into a water bath if the alarm temperature is less than 100°C. Use glycerine bath for temperatures more than 100°C but below 150°C The thermistors are not suitable for temperatures above 150°C. Maintain the temperature within ±1°C of th desired alarm temperature Adjust the 1 K potentiometer such that the alarm just starts

To sense the car engine temperature, the thermistor probe can be mounted at a suitable place on the engine. You may even insert the probe, with proper leak proof arrangement, inside the radiator While sensing the engine temperature from the radiator, the placement of the probe is very important The probe should be placed very close to the point where the radiator receives hot water from the engine At this point one can assume that the water temperature is almost equal to the engine temperature At all other places on the radiator, the temperature will be considerably lower as the function of the radiator is to cool down the circulating hot water.

If you desire to use the over-temperature alarm with the "LED engine temperature indicator" you can delete some of the common components such as the thermistor, zener diode and preset potentiometer This is the reason why the circuit of the "Over-temperature alarm" (Fig 1) is shown in two separate parts The left-hand part can be substituted by the "LED engine temperature indicator" circuit Fig 2 shows the high sensing part of the LED engine temperature indicator circuit and how the IC voltage comparator stage of the "Over-temperature alarm" is connected to it With this arrangement, the alarm will sound whenever the red LED lights The entire circuit of the "LED engine temperature indicator" is kept undisturbed, the only difference being the inverting and non-inverting inputs of the IC 741C are interchanged.



IC 741C	IC 555
1 OFFSET NULL	1 GROUND −VE
2 INVERT INPUT	2 TRIGGER
3 NON-INVERT INPUT	3 OUTPUT
4 −VE	4 RESET
5 OFFSET NULL	5 CONTROL VOLTAGE
6 OUTPUT	6 THRESHOLD
7 +VE	7 DISCHARGE
8 (NO CONNECTION)	8 VCC (+VE)

You will need:

Semiconductors. Integrated circuits IC 741C—1 No., IC 555 - 1 No., Transistor, SL 100 or BEL 100N 1 No., Zener diode, 6.2 V 400 mW 1 No., Thermistor 22 K - 1 No

Capacitors 0 1 mfd polyester or ceramic 2 Nos.

Resistors (all ½ watt type) 10 K 2 Nos., 4 7 K 1 No., 1 K - 2 Nos., 270 ohms—1No., 220 ohms 2 Nos., 100 ohms - 1 No; 10 ohms - 1 No

Potentiometer 1 K carbon linear or wire wound—1 No

Loudspeaker 8 ohms 500 mW miniature 1 No

Approximate cost of the above electric components in the Bombay market, Rs 80 *Misc.* IC experimenter's veroboard, brass probe for thermistor solder, wires suitable enclosure, cooling find for SL 100 transistor, etc

Anil V. Borkar

PSSSST! COMPUTER SECRETS

DO computers whisper their secrets? Yes, they do to any one sophisticated enough to hear them. Every computer constantly and unintentionally emits radio waves which can be decoded with a device designed for electronic spying. These waves are transmitted from parts of the computer like screen, chassis, wiring and power lines. Experts believe that the espionage of this kind could be done and there is a deep concern existing among security conscious computer users, reported in the *New York Times*.

An engineer well acquainted with national security matters who declined to disclose his identity says, "Interception is going all the time. There are people who devote their working energy to trying to find out how to do this not only with the enemy but with friendly nations."

Signals emitted from the individual computers can be blocked easily. At Los Alamos National Laboratory, the rooms containing large computers are lined with copper sheets and other areas where high security has to be maintained have been installed with small isolated computers covered by thin metal plates. However, protection of computers is complicated by number of characteristics of computer revolution such as increasing frequency of computer signals which require more refined shielding. At the same time the tools used by spies to decode signals are becoming better and more widely available as semiconductors "chips" used in the detection process become cheaper and more sophisticated.

For unknown reasons, this kind of electronic spying is known as "Tempest". A computer security expert at the Army's Material Development and Readiness Command said, "The Department of Defence believes the Tempest problem is increasing. When you used to handle classified information manually there was no problem, with automation it is another story."

The most worrisome problem is that one day computer espionage may enter the business world. In order to overcome this problem some standards have been set up for reducing computer emissions in places that deal with sensitive information such as banks, stock brokerages and commodity markets," says Philip C. Thomas, head of security systems at Wang Laboratories, Inc. According to Anthony Canova, head of radiation testing at Chomerics Inc., a company in Woburn, Mass., that manufactures products to block radio frequency emissions, "The range over which a computer's signals can be picked up is highly classified and dependent on the level of electronic pollution" in the area under surveillance, but 500 feet is not unreasonable at all.

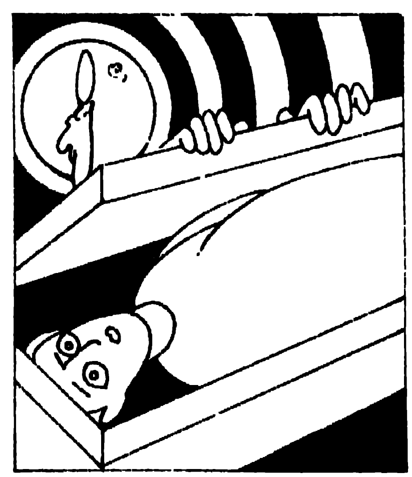
A radio wave can be created by every spark. So digital switching in a computer causes radio signals to spread in all directions, even back into the power line. When an operator presses the "C" button for example, or any other key, unique signals are radiated from a word processor which can be easily picked up by special antennas and decoded by sophisticated tools such as spectrum analyzers and powerful computers.

This technique is almost thirty years old, but it is only in the past few years that the need for its defensive side has been recognised in the United States government, and its security agency has instructed computer makers to build special computers with built-in shields that block radio signals. Small computers can also be covered with metal and the screen with a thin metal mesh. The electrically conductive paints and other high technology materials have become substitutes for using on the inside of plastic cases of the computers.

Girish Kunkur

Mr Kunkur, who, until recently was Reference Assistant in SCIENCE TODAY, is now Assistant Books Officer in the British Council Library, Bombay.

When corpses walk...



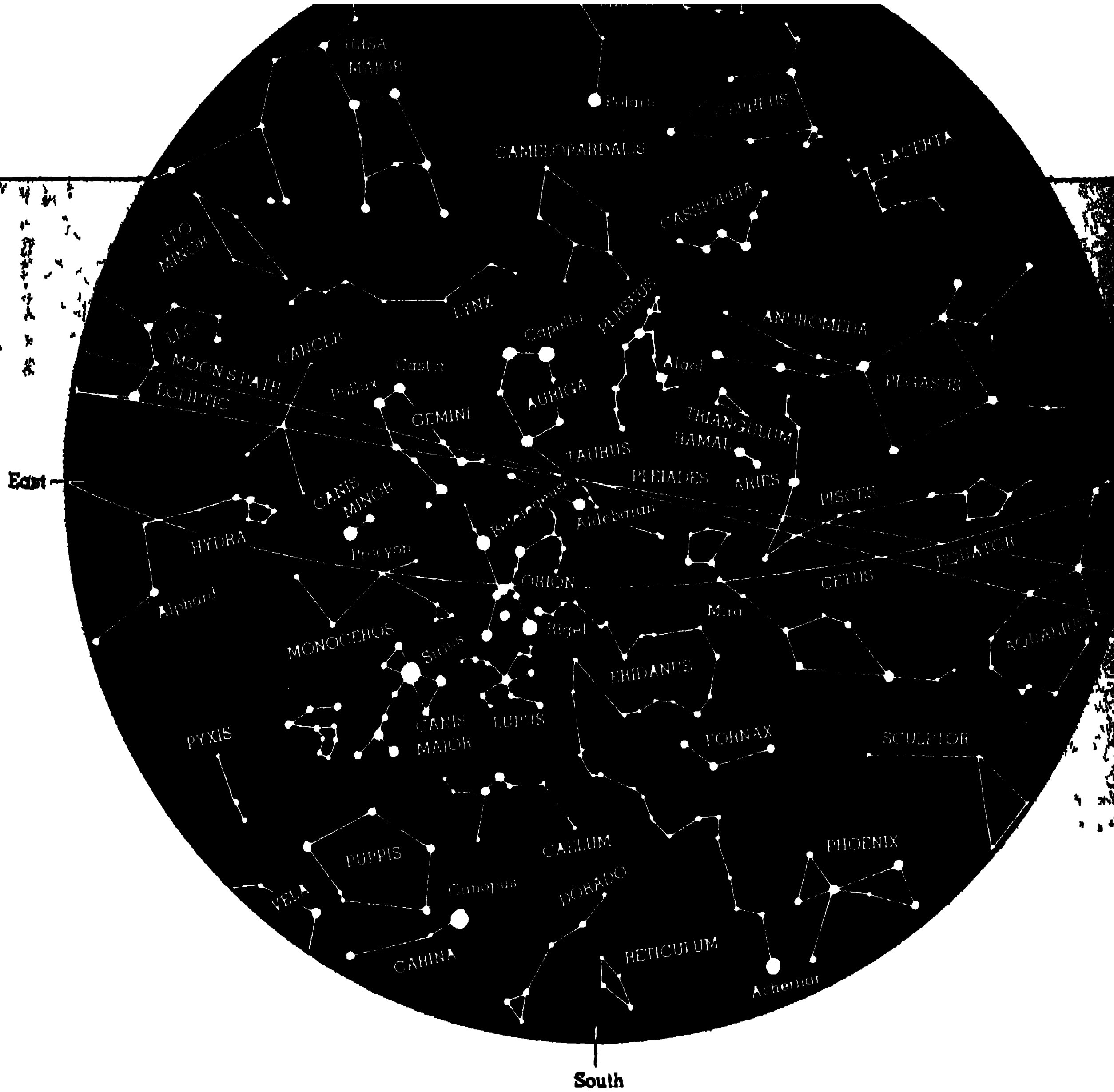
THE existence of zombies (corpses said to be revived by witchcraft) has been a controversial issue and now a Harvard botanist, E. Wade Davis concludes that "Zombiism exists and is a societal phenomenon that can be explained logically".

Davis joined Lamarque Douyon, a Canadian-trained head of the Psychiatric Centre in Port-au-Prince in Haiti who has been trying for 25 years to establish the truth about the phenomenon. Both of them studied five cases very closely, particularly that of Clairvius Narcisse, a man declared dead in 1962 but reappeared again in 1980 and recognised by more than 200 people.

Douyon believed that Narcisse was poisoned by his brothers because he refused to go along with their plan of selling the family land using a zombie potion in such a way that his vital signs could not be detected. Davis's analysis of the potion obtained from the malevolent voodoo priests known as "bocors" revealed that its active ingredients were a large New World toad (*Bufo marinus*) and one or more species of puffer fish. The toad, according to Davis, contains hallucinogens, powerful anaesthetics and chemicals that affect the heart and nervous system. The fish contains a deadly nerve poison called tetrodotoxin.

These poisons first lead to difficulty in breathing, glassy eyed stare and then final paralysis, and yet the mental faculties are not lost. The effect of the poison depends on the dosage: too much will kill too completely and resuscitation will be impossible. Even with the correct dose, the bocors told Davis, a zombie must be exhumed within about eight hours or will be lost, presumably to asphyxiation.

It is still a mystery how zombies are revived from their deathlike comas. Once a zombie is revived, says Davis, it is forcibly fed with a paste made of sweet potato and *datura*, an extremely hallucinogenic plant, and led away in a state of intoxication to work as a slave. Narcisse spent several years as a slave in a sugar plantation. But zombies do not make very good workers. After their ordeal their senses are so distorted that the slightest effort needs great effort.



SKY IN JANUARY 1984:

All planets in the morning sky

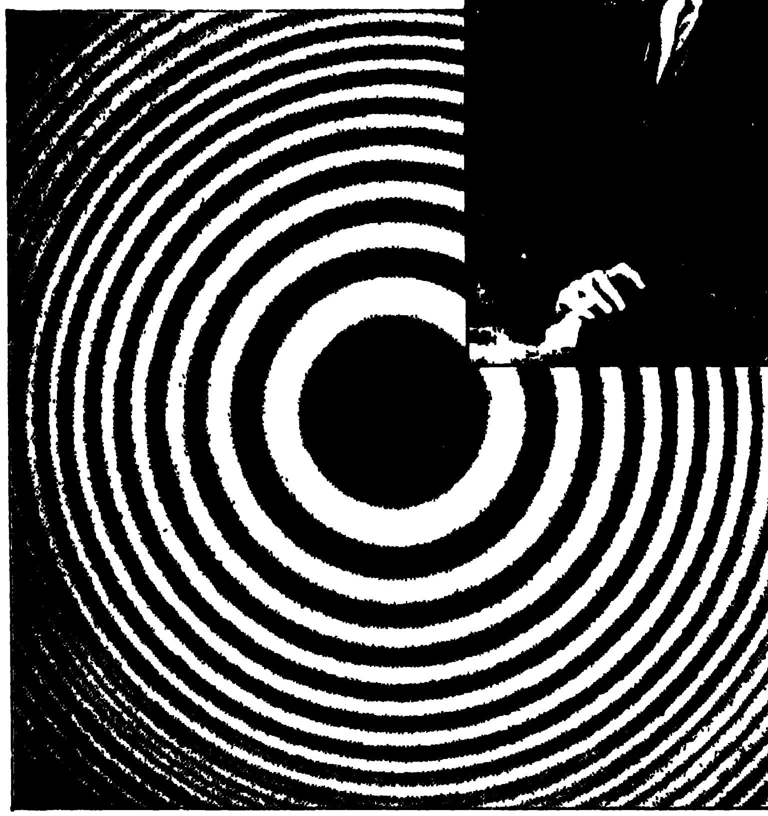
Nagpur 21 00 Hrs (IST)
As on 15 January 1984
Magnitude limit 5 0
Latitude 21°9 N
Longitude 79°6 E
Sidereal Time ~ 4h

DURING the first two months of the new calendar year, all the nine planets will be present in the morning sky and the best time to observe them would be about an hour and a half before the local sunrise on any day of the last week of January. During this year there will be a total of 27 events of lunar occultations of planets, mostly with Saturn, Uranus and Mars. Unfortunately only two of them will be seen in India, each being an occultation of Saturn by the Moon on 26 January and 10 June. There will also occur a total of three penumbral eclipses of the Moon and two central eclipses of the Sun during the whole calendar year.

Mercury will be best seen in the morning sky during the last week of January till the middle of the next month, becoming brighter every day and gaining in phase. Venus is now gradually receding from the morning sky; its apparent brightness is falling and the angular size is decreasing steadily. On the 27th early morning Venus will be seen about a degree north of Jupiter. Mars rises every day around the midnight. It will move to Libra by the end of the month. Saturn is a little ahead of Mars and will remain in the constellation Libra throughout the year. Jupiter will be seen somewhat below Venus till the latter crosses the former on the 27th. Through a telescope, the rings of Saturn will be distinctly visible. The Moon will pass by Mars on 25th, Saturn on 26th, Uranus on 28th, Jupiter on 29th, Venus on 30th and Mercury on 31st.

N. C. RANA

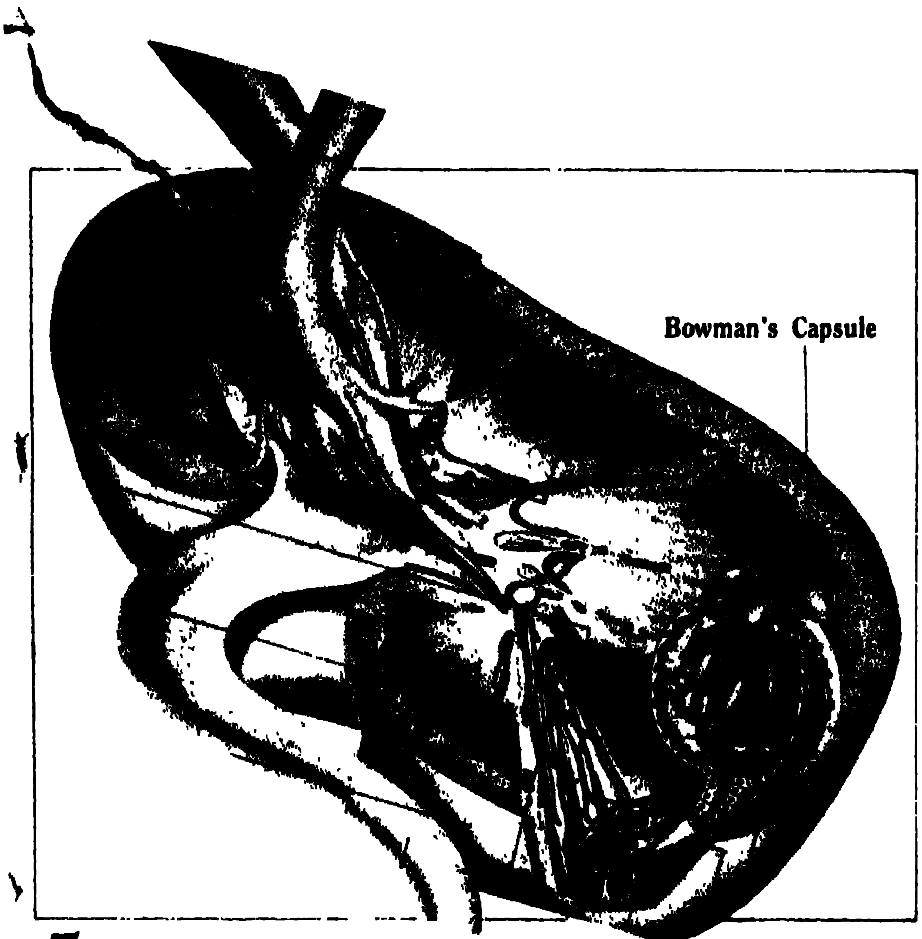
1. Chandrasekhar Limit—B: It is the limiting mass of the helium core believed to exist in some stars above which the core cannot resist ultimate gravitational collapse. The limit lies at about 1.44 times the total mass of the Sun. It was first calculated by S. Chandrasekhar (b. 1910) who shared the 1983 Nobel prize.



2. Bose Particle—C: Any member of a set of elementary particles having integral units of angular momentum (spin 0, 1 etc.). These are named after Satyendranath Bose (b. 1894—d. 1974) who formulated new Quantum Statistics which describe the behaviour of these particles also called as Bosons, which obey the Bose-Einstein statistics. Bosons include photons, mesons or even number of nucleons also the recently discovered intermediate vector boson (associated with radioactive decay) and the proposed particle graviton (associated with gravitation).

3. Newton's Rings—B: A series of circular bright and dark bands which appear about the point of contact between a glass plate and a convex lens, which is pressed against it, and illuminated with monochromatic (light of one colour) light. The rings are due to the interference of light at the thin film of air between the glass surfaces. These rings were named after Sir Isaac Newton (b. 1642—d. 1727) the famous scientist.

4. Islet of Langerhans—B: A mass of cells in the pancreas secreting insulin. This is named after Paul Langerhans b 1847—d. 1888 a German anatomist.



5. Bowman's Capsule—C: A two layered membranous sac surrounding the capillary loops inside a kidney capsule. It constitutes the closed end of a nephron (a functional unit of the kidney). This capsule is named after—Sir William Bowman (b. 1816—d. 1892) surgeon and histologist.

8. Lissajous Figures—C: The displacement pattern traced out by the superposition of two vibrations in directions at right angles to each other. These figures can be constructed graphically or they may be obtained on the screen of a cathode ray oscilloscope. These figures can be used to determine the frequency of a vibration. These figures were named after Jules Antoine Lissajous .(1822-1880) French mathematician

9. Archimedes's Screw—B: A device for raising water by means of a rotating broad-threaded screw or spirally bent tube within an inclined hollow cylinder. Archimedes (287 BC—212 BC was a Greek mathematician and inventor.

10. Petri Dish—B: A shallow glass or plastic dish with a loosely fitting overlapping cover used for bacterial plate cultures and plant and animal tissue cultures. Julius Richard Petri (d 1921) was a German bacteriologist

6. van der Waals' Force—A: Weak intermolecular and interatomic forces that are electrostatic in nature. Some molecules have a positive charge at one end and a negative charge at the other forming a permanent dipole If such molecules having permanent dipole moments are in random thermal motion then some of their relative orientations cause attraction or repulsion. These forces are named after Van der Waal (b. 1837—d. 1923).

7. Van Allen Radiation Belt—B: One of the belts of intense ionizing radiation in space about the earth formed by high—energy charged particles which are trapped by the Geomagnetic field. This belt is named after James Alfred Van Allen (b. 1914) U.S. physicist.

Hail the Winner

IN reply to our November quiz readers literally sent in "myriads of meters"! We were both overwhelmed and gratified by their response... imagine going through hundreds of entries that list meters ranging from the familiar calorimeter to exotic sounding devices like algesichromometer (which, incidentally, records the time required to produce a painful impression) Even after we closed the competition, entries kept coming in Ultimately we had no alternative but to take the unprecedented step of declaring two winners —to Dr V.S. Madgundi from Solapur goes the first prize for the maximum number of meters— 290 to be precise We have also awarded a special prize to Master Ashok Mendonca of Mangalore for a commendable list of meters'

Win a Prize

FOR this month's quiz we want you to send us as many entries as you can about scientists—the laws and phenomena in science that are named after them. Remember to send in a little explanation with each item The closing date is February 5, 1984.

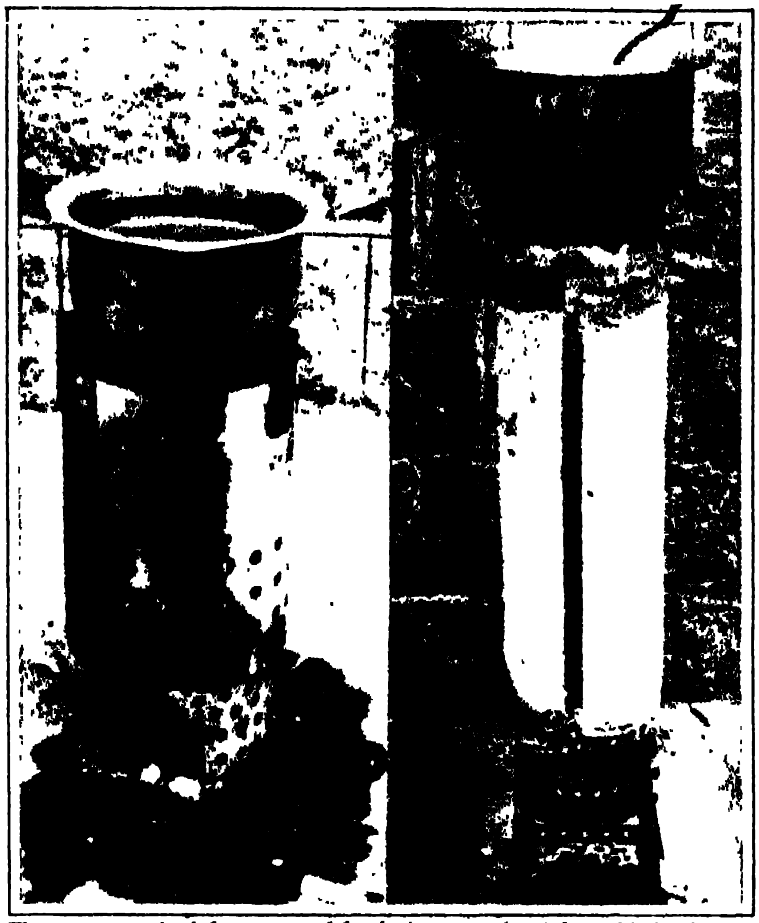
FUEL EFFICIENT STOVES

THE Indian Institute of Science, Bangalore, has designed two stoves which may provide an answer to fuel shortages in rural areas of the Third World

One of the stoves uses wood for fuel. Its main component is a hollow tube of non-combustible material. Its length is trimmed to suit the height of the housewife and its diameter is determined by the amount of fuel it is supposed to burn. A number of holes are drilled at the base of the tube to help draw in air for combustion The lower portion of the tube is covered with a grate framework to discharge ash and cinders.

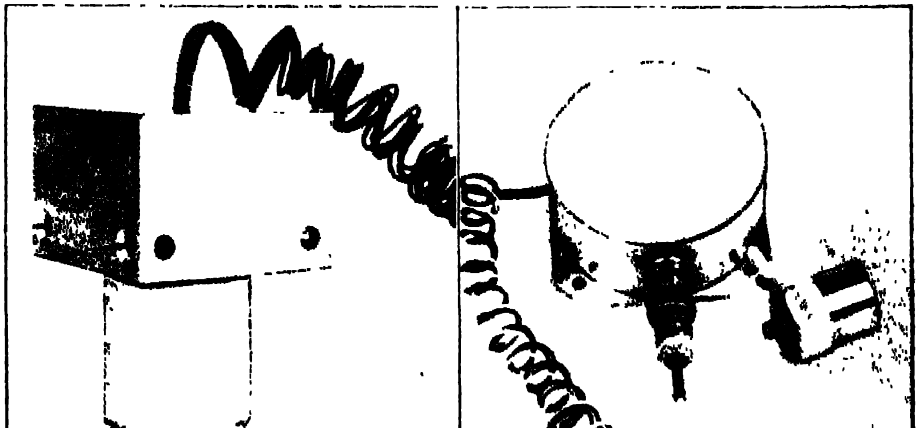
The fuel is ignited with a burning piece of charcoal or cowdung introduced at the bottom of the stove along with a few small pieces of wood. The stove consumes wood at the rate of about 500 grammes per 20 minutes and attains temperature upto 1,200°C. It takes 14 minutes to boil about four litres of water and utilises 750 grammes of wood to cook a kilogramme of rice. The stove is virtually smokeless even when recharged with damp fuel. It was tested over a period of six months and was found to perform satisfactorily.

The second stove uses paddy husk, dried leaves and cowdung in dry cake form as fuel It is made of a metal sheet fashioned in a tubular form, with small holes at the bottom for air flow to aid combustion. Ash is removed by stoking The stove is lighted using charcoal The stove takes 15 minutes to boil four litres of water.



The stove on the left uses wood for fuel and on the right paddy husk, dried leaves and cowdung in dry cake form

Accelerometer and vibration pick-up



Vibration pick-up

THE Indian Space Research Organisation (ISRO) has developed piezo-electric vibration pick-ups with charge amplifiers to measure vibration and shock encountered in rocket motors during static and flight tests These accelerometers, however, can also be used for measuring vibration and shock encountered in industrial machines, machine tools, vehicles and structures.

These pick-ups are of isolated compression type. The piezo-electric sensing element, when subjected to mechanical stress induced by vibration and shock, produces an electric output proportionately

The ISRO has also developed strain gauge accelerometers for monitoring the accelerations of rockets during flight These accelerometers can also be used to measure the accelerations of any moving object.

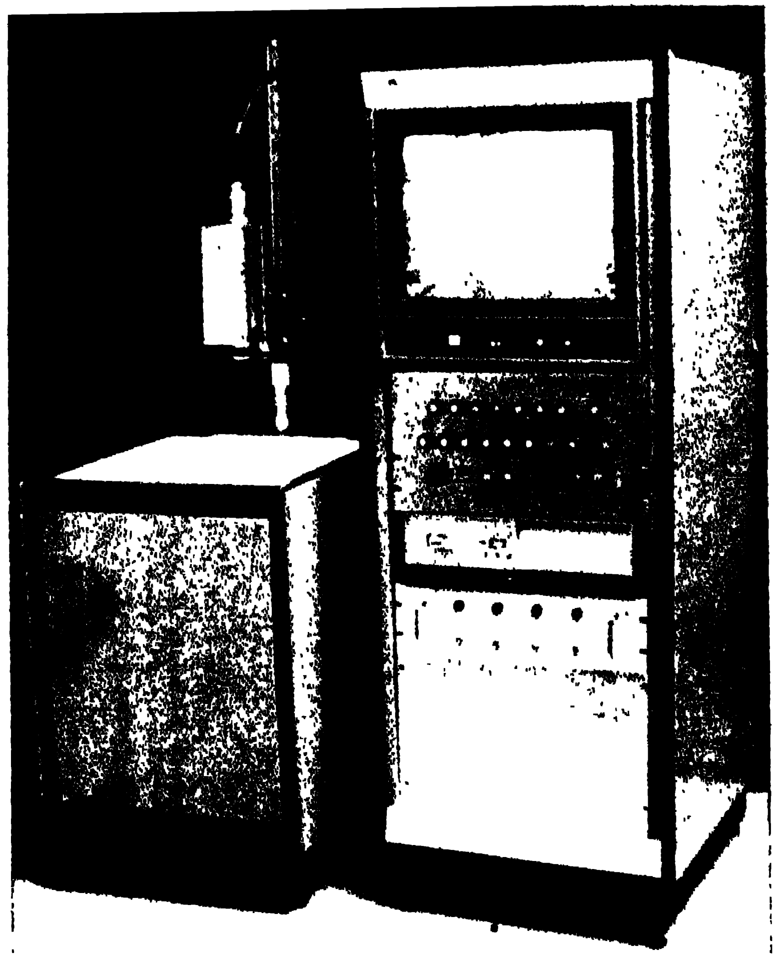
The accelerometers use a tapered stainless steel cantilever beam with a constant strain distribution along the axis of the beam and a mass at the end. The beam and the mass constitute a spring mass system. The damping is provided by a suitable damping fluid. The strain gauges and adhesives provide thermal matching and bonding properties. These accelerometers need recalibration every six months.

Analog image analyser developed

THE National Remote Sensing Agency (NRSA) of Department of Space, Hyderabad, has developed an analog image analyser for analysing black and white transparencies.

The analyser consists of a light table which illuminates the transparency and a vidicon camera to view the illuminated portion. The camera is provided with horizontal and vertical drive signals, synchronising pulses and other controls. The output video signal of the camera is fed to a video processor where it is sliced into eight ranges using comparator logic circuits (CLC) The output of CLC, after several processes, is obtained in eight colours corresponding to eight black and white levels.

The display of colour version of black and white transparencies has its uses in the analysis of remotely sensed images, biomedical research and in forensic science.



Light table with vidicon camera above it and the image display screen

Special surface effect on leather

A TEAM of scientists from Central Leather Research Institute (CLRI) of Madras has invented a method of producing special surface effects on finished leather surfaces. A clearly visible grain effect could be produced on finished leathers by this simple and cheap process

The chemicals required for this process are a weak base and a weak organic acid. The chemical compound is applied on the flesh side of the leather with a brush or an ink-filter along pre determined lines or design If a random design is required, the chemicals may be merely sprinkled. On applying the chemicals, the phenomenon of shrinking starts. Predominant surface grains appear and the process is completed on drying.

The drying of the leather takes only a few minutes. Once the leather is completely dry, it is slightly hand-boarded to remove the dried-up chemicals. Stretching is done at a later stage. Some of the grain effects produced are popcorn effect, quilted and pebble design.

The chemicals can be applied by wooden blocks also, as in textile printing, on a commercial scale. For this, a stamp pad is prepared and this is soaked with the chemical compound. The wooden block with the necessary design is soaked with the chemicals and stamped on the leather surface.

The technique is ideally suited for semi-chrome grain garment, suede leathers and also vegetable-tanned leathers The thickness of the leather should preferably be 0 7 to 0.9 mm

Medicinal garlic

GARLIC powder has immense uses not only in cooking but also in medicinal preparations because of its carminative, anthelmintic and antiseptic properties

The Central Food Technological Research Institute (CFTRI), Mysore, has worked out an improved process for the manufacture of garlic powder. This technique effects a considerable saving of time and labour and the product has better colour, flavour, antibacterial activity and also pharmaceutical value.

The technique consists of scrubbing of the garlic bulbs under mild pressure to remove the skin. The cloves are then conditioned and dehydrated. The husk is removed and the cloves separated. The dried cloves are powdered to the desired mesh size and packed in air-tight containers.

Computerised microwave oven

AN electronic concern based in Seoul, South Korea, has developed a microwave oven controlled by a microprocessor which displays power level, temperature, cooking time and time of day

The oven can operate in either a 4-stage temperature cooking mode or a 3 stage time cooking mode by setting the computer programme accordingly. The cooking can be delayed for up to 11 hours and 59 minutes by programming the oven, pressing the delay start pad and setting the desired delay time.

The memory entry and recall system enables the user to store a recipe in the memory of the oven which can be made to repeat automatically when needed. The LED indicators provided show the various stages of cooking that have been programmed into the oven. In addition, the oven has a temperature probe with indicator lamp which lights up when the food has reached the desired temperature and automatically turns off the unit.

No robot can feel the pounding of blood in the head as I am feeling now...

(Continued from page 41)

appealed for help from the riot police.

Normally one would have sent such a robot straight away to the scrapeyard. For nothing is so dangerous in the ancient robotic codes (established in the pre-fusion age) as a robot that dreams or in any way displays irrational or intuitive behaviour.

Why then did we desist from destroying the robots present in the master control room *en masse*? First, because we did find a table that was cracked and splintered as though a giant sledge hammer had landed on it. The question is who did it? It could be the greenman (who boasts of strange powers acquired as a result of living in the open outside the dome) Second, we did find marks and bruises on the person of the pink master. So the robot's account that the pink master felt no hurt nor harm is suspect (we have quarantined the robot concerned). Also, the greenman did not seem to be as frightened as the pink master, who seemed to shake like a case of alpine blues.

It can't be You all know me. That madman Manav Chaudhari should be disintegrated. He is merely spreading the canard that I am metallic because he wants me to be out of this post. He calls anyone opposed to that mad movement of his, "bot" You know I even remarked what a pretty wife that madman had! I could feel her beauty like a pain in the chest, after all these years spent in the lonliness of this room. Could a robot have appreciated beauty? I feel, therefore I am...I am human that is . .

But what if that mad Manav is right? Of course, how dumb of me ... after all these years.. No human could have surived that dreadful crash ... Does that mean the love I still feel for my dearest Sona, for my lovely Mina, is false? Impossible! No robot can feel the pounding of blood in the head as I am feeling now... Oh, I must be growing old now ... shouldn't have fought with that arrogant rapscallion...

There is only one way left to prove him wrong... I must use the cryochisel. Let us see where the green switch of the chisel is located... Why are my hands trembling thus? Does that happen to a robot? Ha! Why don't you answer me,you dumb robot? Yes, you there at the end of the assembly line! I address, nay, command you to stay away from that alarm. I am the boss here and I'll show you that hot human blood flows in my veins not pallid freon...

The Board of Directors of Bharat Robotics is immensely grieved over the sudden and untimely end of that most illustrous colleague, Chief Aloke Andharay. He died of shock. He was our first brain-child, neither fully robot nor man. His was a mind too valuable to lose on the smouldering wreckage of the car which was undoubtedly sabotaged .... We transplanted his brain neural network by neural network to prove that man and metal can and must indeed live in harmony—inside the same frame. That is the only way to defy necrosis that must ultimately creep upon us... Although we saved his mind, we could not protect it against the shocking sight that was the outcome of his grisely experiment. As you will appreciate, he himself could not have been warned. For to do so was to risk the very end that has finally overtaken our brain child... But his death will not have been in vain if those misguided souls from outside realise at last that we mean no harm to humankind...we want humankind to survive and it can only surive if it cooperates with their cybernetic cousins, the robots... good night. □

Mr. Ghate, a popular science writer, is Editor Srishti Dnyan, *a marathi science magazine published from Pune*

BIRESH CHANDRA GUHA AWARD

The Indian National Science Academy has awarded the Biresh Chandra Guha Lectureship: 1984, to Professor B. K. Bachhawat, director, Indian Institute of Chemical Biology, Calcutta. This is in recognition of his pioneering contributions to neurochemistry, protein energy malnutrition, liposomes as specific target-oriented delivery systems, glycolipids, glycoproteins and lectin in enzyme immuno-assays

SWAMI PRANAVANAND SCIENCE AWARD

Professor Leela Mulherkar, former head of the zoology department, University of Poona, has been presented with the first Swami Pranavanand Science Award for Departmental Biology by the Indian Society of Developmental Biologists The award has been given in recognition of her pioneering contributions to teaching and research in the areas of early development of the chick, teratological studies and environmental aspects of developmental biology.

S. R. GOWARIKER

Dr. S. R. Gowariker has been appointed director of Central Scientific Instruments Organisation (CSIO) Chandigarh Earlier, he was head of the Technical Physics Division of Bhabha Atomic Research Centre (BARC) Bombay.

Dr. Gowariker was concerned with the development of neutron counters in BARC which he joined in 1955. Later as scientific officer in its Nuclear Physics Division, he was responsible for the design and fabrication of the electromagnetic isotope separator built for the first time in the country with major components indegenously developed He also played a major role in building the variable energy cyclotron at Calcutta. He had the overall responsibility of coordinating the various R&D activities of BARC before his present appointment

M. P. DHIR

Dr M. P Dhir has been appointed director of the Central Road Research Institute (CRRI), New Delhi. With CRRI since 1957, he has been heading its Roads Division for the last 15 years

Dr. Dhir's contributions include a new pavement system for desert areas, evaluation of granular mixes, improvements in bullock cart designs, test-track research and rural roads Among his consultancy assignments, includes the designing and construction of the velodrome for Asiad '82.

Associated with several technical committees of the Indian Roads Congress and other institutions, Dr. Dhir is involved in the identification of R&D needs and thrusts in highway engineering

HOW MANY WICKETS KAPIL?

IN A recently concluded test series the total number of wickets claimed by Indian bowlers was exactly 100

Kapil took the highest number of wickets which was a perfect square Binny got the least number of wickets Madan fared better than Binny and the number of wickets claimed by Madan, was also a perfect square Ravi took as many wickets as Kapil

How many wickets were taken by each bowler?

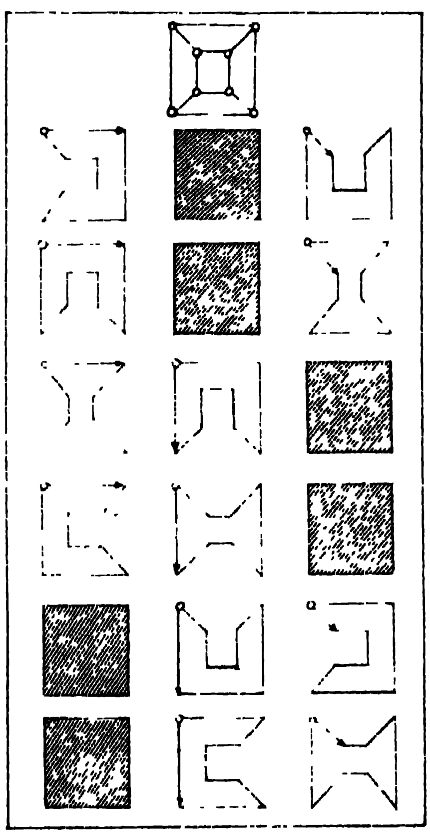
S. N. Bableshwar

(Solution next month)

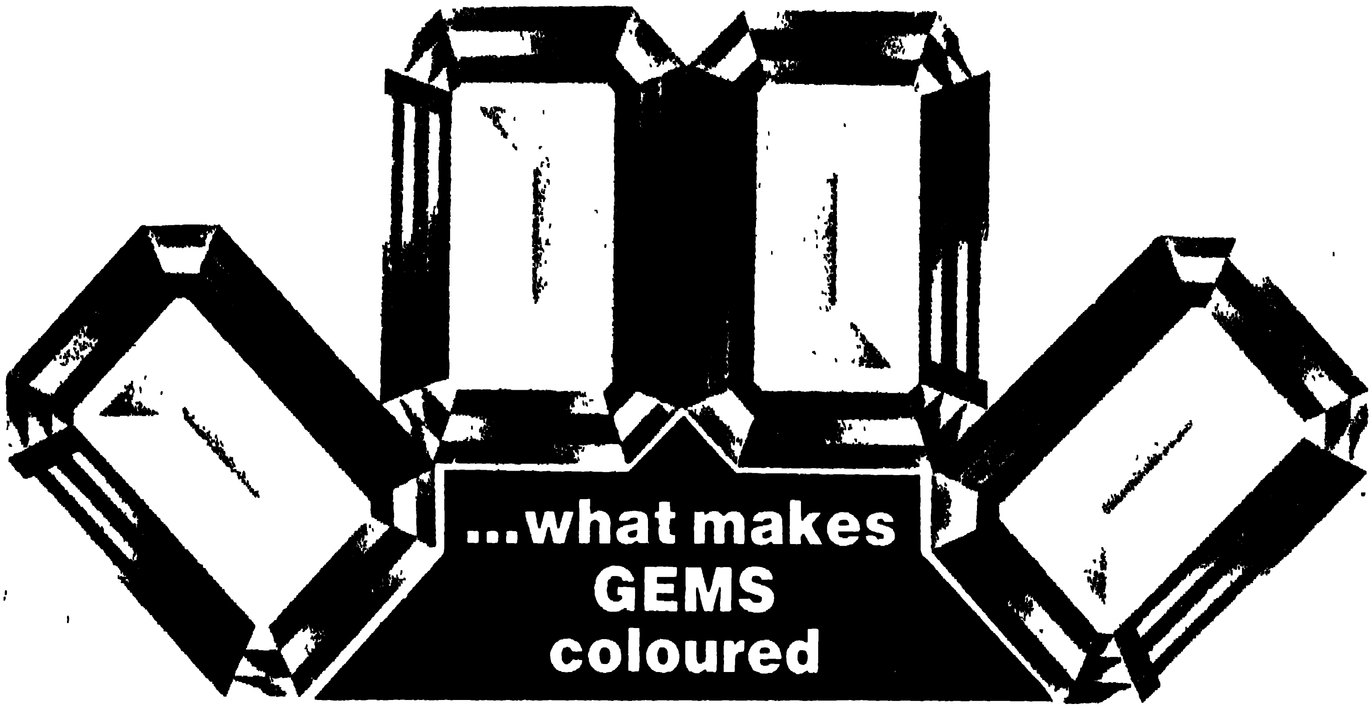
Solution to last month's brain teaser

THE THREE ANTS'HOLIDAYS

TOPOLOGICAL problems of this type can be solved with the help of 'planar graphs' Shown alongside is the 'planar graph of a cube revealing all its 12 edges the routes along which the ants could travel Starting from any one point, one has initially 3 directional options available, but having chosen one of them at the next station only 2 are available because back tracking is not permissible At the next corner 2 options are once again available, but thereafter if all the remaining points have somehow to be covered in the time assigned, there is only one way of doing so The total number of closed circuits possible from a vertice back again to itself is therefore 12 (that is $3 \times 2 \times 2 \times 1 \times 1 \times 1 \times 1 \times 1$)



If these paths are marked on the planar graph format in three sets (one for each direction of starting as in the accompanying diagram), it will be found on comparing them that for every one route there is one more and only one more which is compatible with it, in the sense that it can be traversed without the ants converging on the same vertice at the same time Such compatible routes have been shown in the diagram in the same row As the third partner is always missing in these sets, the plan which the ants had in mind for separate holidays is not one which can be adopted in the manner they had envisaged



...what makes GEMS coloured

IN the language of criminals diamonds are "cool ice" - colourless bits of carbon that can make or break fortunes. However diamonds come in different colours such as yellow, red and blue. What makes a diamond like Hope blue? It is a fascinating question which takes us into the heart of coruscating carbon.

How does the same material, carbon, assume such various hues? The answer is simple: due to various impurities. Actually it is the electrons from these impurities which respond variously to the different wavelengths of light and impart many splendoured hues to the gems.

Thus, in the absence of impurities, a colourless diamond may be 'coloured' by changing its electronic states, for instance, by means of heat, gamma-rays, and neutrons. Heat treatment is one of the most widely used techniques to 'dye' diamonds.

Neutrons produce uniform colouration. When radiation of low penetration is used colouration appears only in thin surface areas. A diamond irradiated with neutrons turns green. On heating in an inert gas atmosphere at about 900°C, the colour changes to brown and then to an attractive golden yellow. Upon the nature of the impurities present, an irradiated diamond may acquire different colours, too. Thus it may turn bluish, reddish or purple. The important colourants are traces of iron, chromium, nickel, titanium.

Diamond is said to be colourless only in the chemically pure state. The impurities impart colour by absorption. For instance when white light passes through a ruby it emerges depleted of its violet and yellow green components. Essentially, all of red is transmitted, alloy with some blue, giving ruby its deep red colour with a slight purple cast. (The basic material of ruby is corundum, an oxide of aluminium with the formula Al_2O_3. Pure corundum is colourless but in ruby a brilliant colour results from the substitution of a few per cent of aluminium ions by chromium ions (Cr^{+++}) which are the vital "impurity" transforming corundum into red ruby.)

Since impurities are not always same, variation of colour is not unlikely. This is so not only with diamonds but also with other substances, such as corundum, quartz, beryl called allochromatic.

Then there are substances which do not change colour. These are self coloured and hence are known as idiochromatic. Some of them are azurite ($2CuCO_3 Cu(OH)_2$) and peridot ($(Mg,Fe)_2SiO_4$). Copper and iron are respectively the colouring elements. Turquoise ($3Al_2O_3 CuO 2P_2O_5 9H_2O$) is another idiochromatic substance which gets its characteristically attractive hue due to copper.

The colour of these substances also can vary provided impurities are added to them. Thus if aluminium in turquoise is replaced by iron, a green shade results, the characteristic sky blue of turquoise is caused by the element copper.

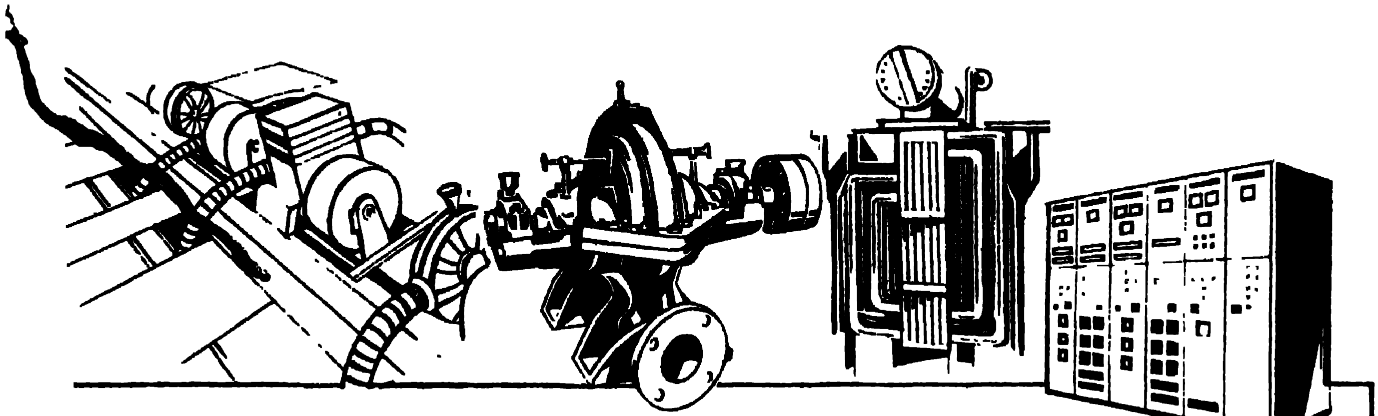
In addition to diamond, beryl and quartz are other common substances whose colours vary depending on the nature of impurities. Beryl ($Be_3Al_2(SiO_3)_6$) exists in the colourless and the coloured forms—prominently green, sky-blue, pink and yellow. The green colour is due to chromium. The sky-blue colour and the pink are respectively due to iron and lithium.

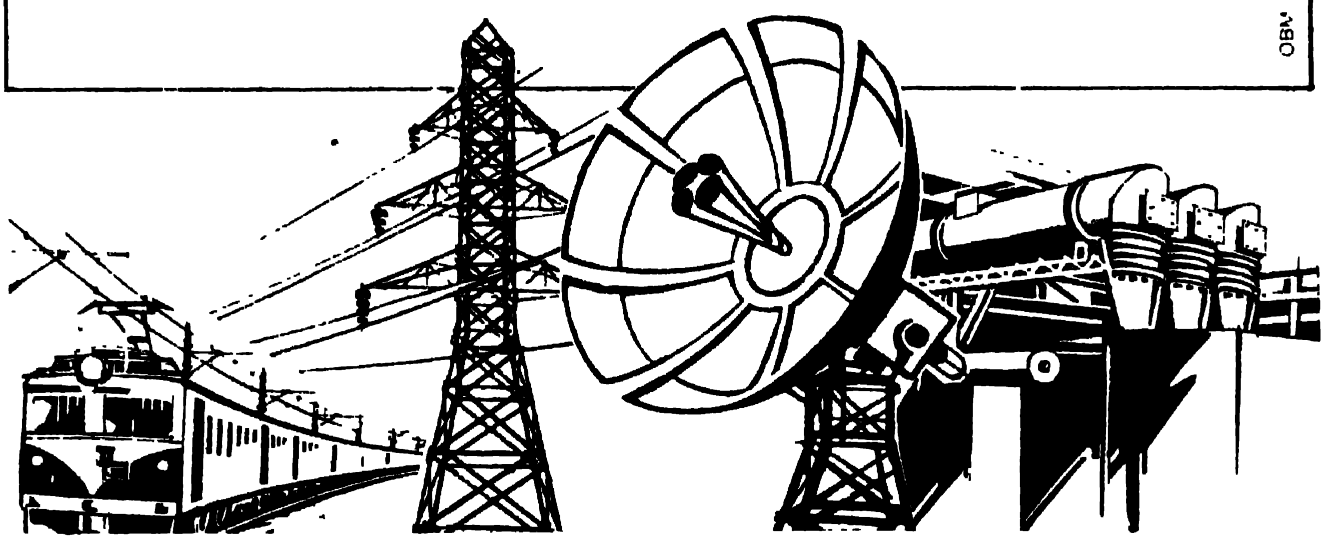
Quartz which is crystalline silicon dioxide also exists in colourless and the coloured varieties. The coloured forms may have purple, yellow, pink colour and others. The colour change is due to the impurities present in them.

Although sapphire and ruby have identical crystal structure and properties such as hardness, density etc, they vary in their colours. Though both are composed of aluminium oxide (Al_2O_3), white sapphire is colourless but ruby is red. The difference is due to the fact that while white sapphire does not indicate any selective absorption, ruby absorbs in the blue region showing red colour.

P. C. Bhattacharyya

Dr Bhattacharya is with the Vidyasagar College in the 24-Parganas in West Bengal





Dattaram NP4/83


SCIENCE
TODAY
Resources for
tomorrow:

MOLECULAR BIOLOGY UNIT

TATA INSTITUTE OF FUNDAMENTAL RESEARCH

If you are a student in the second year M.Sc. or equivalent with a very good academic record and a strong interest in doing research in biology, you can apply to spend about six weeks next summer working at the Molecular Biology Unit of the Tata Institute of Fundamental Research. The areas in which you can work will include biochemistry, developmental biology, molecular genetics and neurobiology. To be considered, send the following in an envelope addressed to The Administrative Officer (Establishment), Tata Institute of Fundamental Research, Homi Bhabha Road, Bombay 400 005, so as to reach him before February 29, 1984:

1. An authenticated copy of your bio-data and academic record.
2. An autobiographical essay, one or two pages long.
3. A clear statement of purpose as to why you are interested in coming here (this should be in about 250 words).
4. A choice of dates; indicate a continuous period of six weeks between 1st May and 31st July 1984 which would suit you (give one or two alternatives, because a hostel room may not always be available; if you do not need accommodation, say so).

The envelope should have the words 'Molecular Biology Summer Programme' clearly written on the outside. In addition, request two persons who are acquainted with you academically to send letters of recommendation in a similarly superscribed envelope directly to the above address, also before February 29, 1984. Selected candidates will be informed individually. During the period of their stay here, they will be paid a stipend of Rs. 500/- per month, return second class rail fare from their place of residence, and, if they want it, will be provided hostel accommodation at their own cost (this will work out to about Rs. 150/- a month or less).

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TODAY

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COVER PHOTOGRAPH
BY UDAY DUNDAPPA

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WHENEVER an impressive scientific project is launched or completed sceptics have questioned its relevance to our social conditions. Be it the Rohini or INSAT-1B roaring into the skies, an atomic reactor reaching criticality or a particle accelerator speeding charged particles, doubts have been expressed about the country affording such an extravaganza. "Where is the wisdom", it is asked, "in frittering away valuable resources, financial as well as material, on 'big' science". "What we need", the critics go on to exhort, "is greater attention to problems of immediate nature such as, say, designing a more efficient bullock-cart or a stove which consumes less fuel". The support to these viewpoints is usually sought in the argument that ours is a developing nation which cannot bear the burden of expensive research unlikely to provide any tangible benefit in the foreseeable future. In a recent interview to a Bombay newspaper, Prof. Hamilton Smith, the Nobel prize-winning geneticist also forwarded the same argument, albeit hesitatingly, when asked whether India should embark upon an ambitious programme of research in genetic engineering.

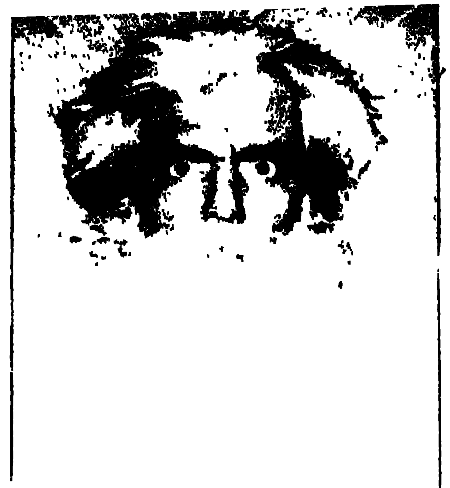
The presumption is thus gaining ground that this debate between 'big' science and 'small' science is peculiar to a developing nation. A report in a recent issue of Nature *should dispel this notion. The Association of British Science Writers had organised a public meeting to discuss the question "Should Britain invest heavily in 'big' science?" Britain by no yardstick can be considered as a developing country. And yet there was heated discussion regarding the relative merits of 'big' and 'small' science.*

The proponents of 'big' science were mainly the astrophysicists and nuclear physicists. Prof. Pounds, the astrophysicist, pointed out that even though the gigantic physics projects entail large capital expenditure, they provide value for money by enhancing our understanding of terrestrial climate as well as the extent of natural resources. Further, according to him, "astronomy has the capacity to excite and even inspire members of the general public with new concepts like black holes and gravitational lenses".

In contrast, those who refuse to keep their heads in the clouds and want to plant their feet firmly on the ground like Dr. Colin Humphries, a metallurgist, bluntly state that "while truth and knowledge *are valuable products of 'big' science, little science produces jobs and wealth as well".*

Although the basic question which prompted the debate was left unresolved, it became abundantly clear that the participants in the meeting were chiefly seen to be protecting the interests that they represented. There was no objective evaluation from the vantage point of a broader perspective. It is often forgotten that there is no cut and dried distinction between 'big' and 'small' science. What is termed as 'big' science can many a time have a beneficial fallout. On the other hand, even 'small' science these days does require increasingly sophisticated instrumentation which could reach the level of a national undertaking. Time has come, therefore, to stop these divisive arguments and put up a united front to oppose the anti-science league which alone benefits from these futile debates.

EDITOR



Parapsychology-fact or fraud?

Dr. Kanekar's article (October 1983) is extremely biased and one-sided and full of false and misleading statements about particular matters of experimental fact In the interest of objectivity and fairness, this article requires a rejoinder which would provide a rebuttal and present the case for parapsychology in a more objective manner.

K RAMAKRISHNA RAO

Director Institute for Parapsychology
P O Box 6847
Durham NC USA

Congratulations to Prof Suresh Kanekar for a bold and forthright article on parapsychology

However, I do not understand why he has avoided to mention the world famous duo, Peter Herbos and Chroiset, who are credited with amazing psychic feats like telling the past and present of an article by simply touching it

B RATNAKAR

Railway Staff College
Vadodara 390 001

I congratulate you for a logical bold and informative article It should be an eye opener for those educated cowards who believe in miracles which totally go against the established and known concepts of science Such articles should be published in daily newspapers too so that more people can be educated Superstitions have led the masses to believe in things which do not exist. The reults have been inactivity and surrender, only to further aggravate human sufferings

During my visit to a dozen and odd European and African countries including the USSR I found that poverty and suffering are directly proportional to the prevalent faith in superstitions and imaginations It is true that much is beyond the reach of today's science but it does not mean that we should blindly follow the guess work of our ancestors It would be nice to know the author's scientific ideas about the concept of god and the benefits and harm of having faith in him

S K KAPOOR

Senior Scientific Officer
Central Pulp & Paper Research Institute
C P P R I
Dehra Dun 248 000

Being familiar with parapsychology and the method by which it is studied, I find the writer's attempts at examining "as objectively as possible the claims and achievements of parapsychology from the beginning to the present times" rather disappointing The article seems to be, at its best, a polemical exercise aimed at discouraging genuine enquiry into phenomena that challenge the well-established world view of contemporary science While appropriately bringing to light and doubting the validity of some of the early studies, attempts at estimating the status of the field today are biased, and the progress made in its research-methodology grossly underestimated Also one wonders whether the article is aimed at attacking the existing evidence (as it should have), or the scientist has taken upon himself the responsibility of trying to explain the so-called anomalies through the logic of enquiry, science Such pseudocriticism carries with it selective mention of weak evidence and failure to acknowledge the best evidence and defence

With regard to the criticism on the employed research-methodology which the writer vehemently states as being the very ground for the rejection of the phenomena, the fact is that the best critics of parapsychological research are parapsychologists themselves they are certainly as well trained and as well informed on matters of scientific detail as any other scientists One has to just go through the parapsychological journals to see for oneself the dispassionate assessments of each others' works in order to appreciate their acumen for elegance in experimental design

Also, having been a Visiting Fellow at Dr J B Rhine's Institute for Parasychology, and having witnessed the continuous flow of communication (both documented and undocumented) between psi researchers and outside scientists and critics, a stage has come about an agreement between parapsychologists and their critics on issues related to methodology and statistics What continues (and will continue) to be the criterion for dismissing psi is its a priori impossibility or manifest implausibility Unless and until a revolutionary shift in contemporary scientific thought takes place, there will continue to be such rhetorical rejection of the evidence

Besides other misrepresentations of the field, it was disturbing to find the writer breezing through with indiscriminating and tenuous statements about parapsychologists and their work He asserts that "*all* (my emphasis) the alleged parapsychological events in or outside the laboratory are consequences of either error or fraud"

The article definitely calls for clarification but until then it should be adequate to request the reader to keep an open mind and try and get the other side of the story

SHANTI KRISHNA

Vizianagaram Palace Compound
Visakhapatnam 530 002

A Bose to vitalise today's Indian Science

In "Close Encounter (November 1983), you have relevantly stated Sri Jagdish Chandra Bose helped bring about a renaissance of intellectual pursuit in our country He thus rekindled national pride at a time when it was sadly sagging "

The test of any scientific research project is its relevance to improving the life styles of the people Thus any research programme aimed at contributing to the socio economic transformation of a traditionalist society is both necessary and desirable

Regarding the proposal for a science city in India at the cost of Rs 125 crores, one should not presume that such a 'centralised research facility would put a halt to scattered and individual efforts in research Innovative ideas emerge from collective as well as individual efforts

KANWAR DEVINDRA SINGH

Ojhar Town Ship
Nasik

In his article J C Bose the great synthesis (November 1983) Prof M M Moghe writes From 1885 to 1917 he was Professor of Physics in Calcutta University and Emeritus Professor for the next two years' (p 20) D Bose in his article 'The struggle to establish science writes ' But in 1915, when Bose retired as Emeritus Professor from Presidency College ' (p 22)

These two articles confuse me whether Sri Jagdish Chandra Bose was a Professor of Physics (later Emeritus Professor) at Presidency College, Calcutta or at the University of Calcutta According to Acharya Jagdish Chandra, *A Bengali life-sketch of J. C Bose*, written by Chandra Kanta Dattasaraswati (Dev Sahity Kutir, Calcutta, August 1973), Sri J C Bose was a Professor (firstly an Assistant Protessor) of Physics at the Presidency College Calcutta. When in 1913, his term of professorship at the Presidency College ended, it was extended for two years more. And in 1915, when this

term of extension also ended, he was made Emeritus Professor of the college for life with full salary Most probably J C Bose was the first Indian Emeritus Professor

I congratulate you and also the authors on publishing the articles on Bose on the occasion of his 125th anniversary

SABITA DHAR

H S L C Examiner Board of Secondary Education Orissa Quarter No 4/51 New Colony Bongaigaon 783380 Dist Goalpara Assam

In aid of AIDS

The article on AIDS (October 1983) was admirable In our vast country with innumerable gay men, it is necessary that people become aware of what they are indulging in and what the outcome can really be The word gay (or homosexual) may sound catchy and alluring but the reality is different AIDS is like a plague spreading across continents and is being referred to as the "Plague of the 80s"

In India, because of the existing laws, gays are not willing to reveal their identity or get the necessary medical help (as in AIDS) However, those seeking help or information regarding this disease, could get in touch with me There are various organisations and people abroad willing to help gay men in India, so that they do not fall prey to the deadly epidemic - AIDS

ASHISH

P O Box 301

Ciba Geigy overrides safety clauses

Doubts are expressed from time to time that international companies try out their new products on the peoples of the Third World. We would like to inform you about an example which has recently come to our notice.

10 February, 1983 issue of *New Scientist* carried an article about Ciba-Geigy Company spraying its pesticide, Galecron, on six Egyptian children in 1976. A letter by D R. Goldsmith of USA, referring to this article, was published in *New Scientist* dated 10 March, 1983. Ciba-Geigy Company of Switzerland stated its position in *New Scientist* of 5 May, 1983.

According to Dr. Goldsmith, the children of Maharashtra share with the Egyptian teenagers the distinction of being sprayed with the Ciba-Geigy pesticides. He has referred to the paper published in 1979 in the scientific journal, *Ecotoxicology and Environmental Safety* (Vol. 3, p. 325) by Dr. R. R. Rao and his colleagues, department of Toxicology and Pathology, Ciba-Geigy, Bombay and has described two trials of the pesticide, Nuvocron-40. Trial one consisted of a single aerial dousing on five female and twelve male volunteers (?), ages ranging from 13 to 57 years. Trial two consisted of crop-dusting 21 males aged 22 to 50 years for three consecutive days (only 12 men remained to be sprayed for all three days!). Males were sprayed shirtless and females wore light garments, all remained in the cotton field for one hour after each dousing. Dr. Goldsmith has referred to the trials as 'pseudo-research' and has raised ethical issues involved, like the lack of 'informed consent', the exploitation of children as 'volunteers' and the unconscionable use of humans as test animals

The letter from Ciba-Geigy Company states that the trials mentioned above were conducted under the supervision of Government officials in June and October 1975 to obtain the necessary clearance under the Insecticides Act of 1968. The Company maintains that teenagers are regular members of the rural work-force and that the purpose of the trials was to prove that this pesticide does not constitute a hazard to the rural population.

Based on the Company reports, *New Scientist* (10 February, 1983) has concluded that the levels of the pesticides in the farm workers in Egypt and Latin America regularly exceed the maximum permitted for the Company's own employees. The former constantly suffer from dizziness, headaches and diarrhoea. In such circumstances, the Company has chosen to ignore the question raised by Goldsmith about the 'informed consent'—whether the consent of the so-called volunteers was obtained after informing them about all the possible ill-effects of the exposure.

This pseudo-research carried out in 1975 calls into question the degree of the sense of social responsibility and scientific ethics with which some scientists function in India Madhyamumbai Marathi Vidnyan Sangh demands an explanation about this episode from the concerned Government officials, particularly from the Central Insecticides Board, Faridabad as cited by the Company

DR. MANOHAR BHIDE,
GAJANAN SHANBHAG
Hon Secretaries

Madhyamumbai Marathi Vidnyan Sangh Hindu Colony Bombay 400014

Creativity in Indian physics

It is difficult to imagine how creativity appearing in spurts, a non casual phenomenon with origins in non-conscious levels of human perception including the intuitive level- can be encouraged in universities where people with 'consistently good academic record" are preferred, trained for long in memorisation (of subject matter taught in classrooms) and reproduction (of the same subject matter in examinations) processes The UGC norms, regrettably endorse this conformistic approach, and Prof Saral (Viewpoints, June 1983) must have gone through these annoying demands himself in various selection committees as a member/expert.

It is a correct observation that the talented do not stay on in universities but drift towards research institutions where monetary support for investigations comes forth rather liberally. If fundamental research is to be encouraged and sustained in an atmosphere of creativity, it is imperative that the present anachronistic educational system be restructured without any further vacillation so as to retain the talented in higher educational institutions and in a larger context, in the country itself After all, it will be unfair to make demands of creativity from persons who have been conformed thoroughly right from nappy stage.

Prof Saral builds up in an articulate manner the story of the evolution of the "Indian science manager' who lays out resource planning and monetary control of research projects, often with lopsided priorities owing to a lack of clear perception on the individual's part This new breed is in fact a direct product of the absence of sustained academic creative pursuits which at one stage the manager-turned scientist yearned for but could not fulfil because of various (inner) intellectual limitations and (outer) power/control attractions True, physics itself, as a result of its desertion by good potential physicists, became the biggest casualty It is indeed sad that with most of the promising physicists turning managers of planning and evaluation programmes, and with the accepted norm of in built mutual back patting no worthwhile scrutiny can be done by any competent agency individuals of any of the prestigious modern research enterprises at the national level where large chunks of money are being relocated in the name of high-sounding developmental programmes

The recommendation of Prof Saral for encouragement of a few wild growth ventures by creative individuals must be welcomed and followed up, and it must not be ignored even if the researcher in a university-research institution belongs to the much neglected lowermost 'caste" status wise in the hierarchy of positions

K V SUBBARAM

Department of Physics M D University Rohtak 124001 Haryana

Probe breaks kidney stones

AN ULTRASONIC probe has come to the rescue of kidney stone patients They need not undergo the conventional surgery any more to get rid of their ailment.

The new, less invasive surgical procedure involves puncturing a hole into the kidney through outer skin and sending in the probe. The probe helps to disintegrate the stone in the kidney. Gobind Laungani, an Indian urologist attached to the New York Hospital, in the US, says the stones are broken by the sound waves of the probe

Only a seven per cent risk is involved in the new technique which was demonstrated at a convention of Indian urologists in Madras recently. The risk is because of the delicate nature of kidneys which have a large quantity of blood around them

Heavy atoms stripped

URANIUM, which plays a major role in nuclear energy programmes, is also helping scientists verify the predictions of quantum electrodynamics Uranium ion with a single electron is sought by physicists to extend measurements of shifts in the electron energy levels known as Lamb shifts Large enhancements of Lamb shifts in these hydrogen like but heavier ions are expected to throw light on the predictions of the quantum theory

For the first time, it has been possible to obtain a heavy atom stripped of almost all its electrons To knock off the first electron from the atom is easier than the second, and to remove the entire electron cloud is a formidable task indeed In fact, for uranium this required a combination of two powerful accelerators

Bevlac, a combination of two accelerators in Berkeley, California in the US, was used by a team of scientists to accelerate uranium ions in two stages In the first stage each uranium ion reached 13 per cent of the speed of light and lost 68 of its electrons as it passed through a medium containing oil vapour In the second stage, the ion picked up nearly 87 per cent of the velocity of light and was made to pass through a thin sheet of copper. Eighty-five per cent of the ions emerging from second stage were found to be bare and 15 per cent carried a single electron each.

Wanted: Cigarettes with more nicotine

A CANCER specialist, Professor Ferdinand Schmidt, writing in a recent issue of *Medical Tribune* suggests that the nicotine content of cigarettes should be increased.

He points out that since 1960, sales figures for cigarettes have been climbing steeply in industrialised nations, despite the fact, that the number of smokers has been dropping This means that fewer people are smoking more, in spite of the widely publicised link between smoking and cancer Medical statistics also show a rise in the incidence of cancer, regardless of the lower tar and nicotine content of newer cigarette brands.

Schmidt compared the data of 792 bronchial cancer patients (97.3 per cent of them smokers) and found that filters were useless as a protection against

ulcers; stomach, intestinal and oral cancer and other types of tumours. Considering these facts, he concludes that smokers depend on a certain intake of nicotine. When they don't get it due to filters or light tobaccos they compensate by smoking more and inhaling deeply Schmidt, therefore, recommends a reduction in the tar, carbon-monoxide and other poisonous constituents of cigarettes, but not nicotine. He also suggests the use of natural tobaccos in cigarettes because toasted brands need to be inhaled deeply.

Monkey business in space?

IF YOU think the astronauts want to entertain you from space by presenting a pantomime show of monkey "hear no evil, see no evil, speak no evil" you are mistaken It is an innovative way adopted by the crew members of the Spacelab 1 to protest against their banishment from the live television discussion with President Reagan of the US and Chancellor Helmut Kohl of West Germany.

The shuttle management had earlier received a detailed script of the discussion from the White House which was transmitted to Columbia to ensure the crew would know what to say and when to say it According to the White House edict, only payload specialists Byron Lichtenberg, Ulf Merborld and mission commander John Young were to appear in the Spacelab on camera with the President This provoked the banished crew members Owen Garriott, Robert Parker and USAF Major Brewster Shaw to stage the monkey scene during a television test before the discussion started.

The appeal of the shuttle managers to reconsider the language of the script (which some Europeans thought weighted toward West Germany's contribution to Spacelab at the expense of the other European Space Agency States) and the decision to exclude half the crew members was rejected.

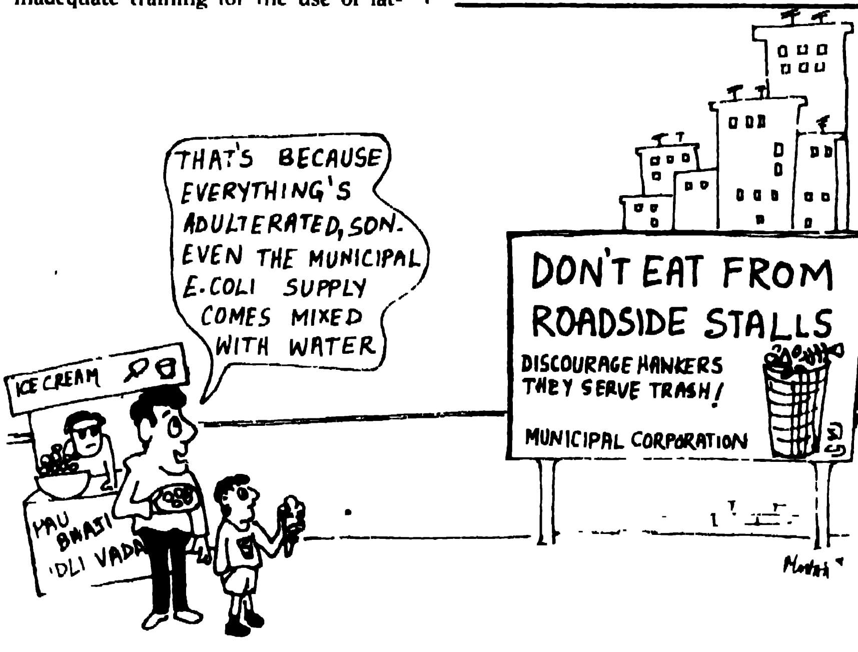
Small is efficient

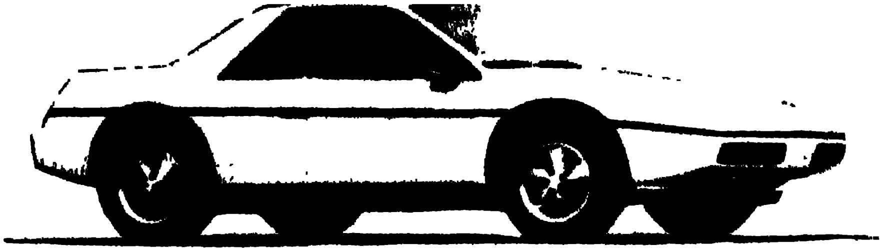
WATER and Sanitation Decade of the United Nations will not be able to achieve desired results in the Third World unless equal importance is given to social factors and hygienic habits of people, reports Debora MacKenzie in *New Scientist* (**100**, 1388, p. 794).

According to the report, there is a lot of mismanagement of various projects at higher levels which "can actually increase the incidence of waterborne diseases". One of the examples of mismanagement cited is of the authorisation by the Indian government to build inflow pipes months before the accompanying drains were ready in Calcutta. The resulting puddles became easy sources for the spread of malaria and diarrhoea. Under another project hundreds of latrines paved with concrete were installed. But overcrowding, lack of drainage and inadequate training for the use of latrines helped to promote the disease.

One of the reasons for this, the report says, is that the UN officials do not work at the field level but deal only with ministries or centralised research stations. Working at the level of villages may help to achieve results more efficiently.

The situation in Bangladesh is none the better where two per cent of children below the age of five die of waterborne diseases. In its efforts to reach the targets of the decade, Bangladesh dug more than 500,000 wells and 200,000 latrines. However, the haste with which these projects were carried out has caused several problems because the engineers did not sufficiently provide for their subsequent maintenance. One of the lessons learnt, therefore, is to implement small-scale projects making use of cheap technology. This also helps in better maintenance of the projects by the beneficiaries themselves.





The body made of plastic is totally rust proof

The all plastic car

FIERO 2M4 is the 1984 sports car from General Motors. 2M4 stands for 2 passengers, mid engine and 4 cylinders. Next year it is going to be 2M6.

The new car is described as the most innovative automobile ever mass produced in the US, built by the most advanced production processes in the world. What makes it unique is its completely rust proof body, which is made of plastic. The body is quite tough too and is expected to last three times as long as its steel counterpart. It is also easily replaceable.

The Fiero's horizontal panel hood, head lamp doors and roof are all made of stiff sheet moulded compound (SMC), whereas its more vulnerable vertical body parts like front fenders, doors, are made of flexible, scratch and dent resistant, reaction injected moulded (RIM) urethane.

How did the engineers come to build the car in the first place? The original proposal was to build an inexpensive two-seat economy car. According to the original design the car began as a front-engine, front drive model. But this made its nose too long and high. So the engine was shoved behind the seats. This mid-engine configuration gave a much higher performance and handling possibilities. The idea of a mid-engine race car led the engineers to build a racer-like structural space frame which completed the project.

Nothing is impossible for laser

RESEARCHERS have demonstrated that the intense beam of light from a stationary laser can be channelled through a needle thin glass fibre to an industrial robot more than 20 metres away, enabling the machine to cut, weld, and drill.

Initial tests have demonstrated an ability to cut intricate patterns in steel, titanium, and nickel based alloys. The fibre optic cable can carry in excess of 10,000 Watts of peak power (400 Watts average) from the laser to the workpiece. A single laser could be "fed" to several robots working simultaneously at separate places.

At present, fibre optics (flexible cables of glass or quartz) are utilised primarily in communications to transmit audio, video, and data signals. They are also used in optical devices employed to inspect inaccessible locations. However, attempts to transmit high power laser light through fibre optic cables have met with only limited success because their protective covering used to get damaged.

This obstacle has now been overcome by devising a proprietary "input coupler"—an optical assembly that "downsizes" the one-quarter-cm-diameter laser beam to the 1,000 micron (one micron is one millionth of a metre) size of the glass fibre within the cable. At the output end of the cable, a lens assembly

focuses the laser energy onto a tiny spot on the workpiece.

Although, high intensity lasers are widely used in industry, they must rely on "hard optics"--lenses, prisms, and mirrors—to "steer" and deliver their energy to the workpiece. Although some systems feature a remotely located laser serving more than one place, they require great care to set up and maintain. Since beam movement is limited to one or two axes, the workpiece frequently must be rotated This makes it difficult to work on parts with complex shapes. By contrast, the new experimental system enables a laser beam to be directed at a workpiece from any direction and angle the robot arm can achieve.

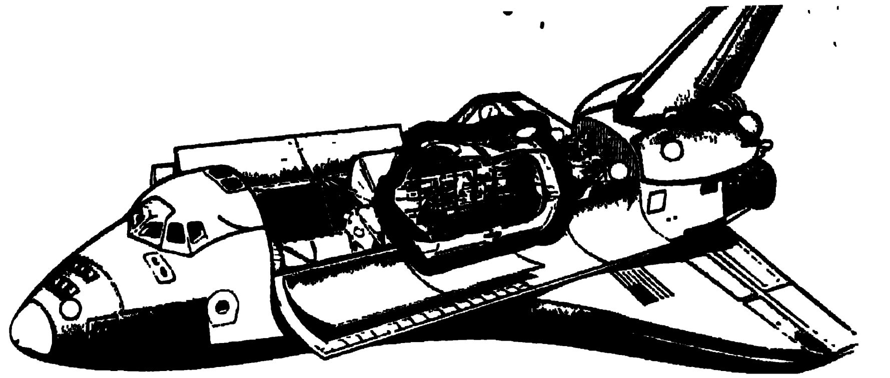
Moral dilemma

TO BE right or to be ethical --that's the question But according to French President Francis Mitterand ethics need not receive first priority says a report in *Nature* (**306**, 630)

Addressing a committee established to look into the ethics of human experimentation as well as life sciences research in general, the President said "Give yourself time, time to reflect, time to discuss and time to appraise the moral issues". Apparently, the dictum is to be right in the long run rather than be wrong in a haste

The committee has a total of 36 members of which 15 are non-technical personnel It is expected to meet at least once in every two months The committee will be assisted by a technical subcommittee which includes scientists from disciplines other than life sciences

This committee will meet more frequently to deliberate on topics such as medical trials of drugs or other chemicals, use of human embryos and surrogate mothers So that the moral aspects of the creation of "children of two mothers as Professor Jean Bernard, chairman of the committee, calls them can be resolved One of the tasks of the committee is to properly inform the media as well as the lay public about all the finer and ethical -aspects of biotechnological developments



Spacelab 1 inside Columbia

Zero G factories

THE near zero gravity in space is attracting—not matter but material scientists. This is evident from the number of experiments planned aboard spacelab 1 in material science, as compared to those in other fields Half of the experiments on spacelab 1 concern the behaviour of materials and their fabrication in space.

The gravitational attraction in space is only a millionth of its value here on ground. Zero gravity means things do not fall but remain suspended wherever they are. If this were the case on earth, we would not be able to build houses, and move about, as we do now Our life style would be radically different

Why do material scientists find gravity a nuisance? On the ground, three factors influence material processing --temperature, pressure and gravity Only the last cannot be controlled, though it complicates considerably material processing by inducing convection, sedimentation etc The insights we get from working in a gravity free environment, promise to revolutionise the processing technology on earth And it may also lead to large scale production in space in orbiting factories

The European Science Agency's experiments on spacelab in material studies are described as "totally different and more sophisticated in many respects than the earlier ones

Many of these experiments aim at gaining a better knowledge about how crystals grow and how this process can be controlled to yield perfect and pure crystals, not possible here when gravity interferes. Contamination by the containers is no longer a problem as crucible free processing is possible in space. Attempts to grow, good and large silicon single crystals, single crystals of two enzyme proteins and an organic metal by various techniques form a part of the study A metallurgical process called directional solidification will be the subject of several studies This technique is used on earth to make turbine blades. Scientists would like to see how a high temperature eutectic alloy would solidify in a thin aluminium oxide skin The skin produces a steep thermal gradient in the molten material, which imparts the solidified state of the alloy improved strength Only in space can such a film support a dense molten mass. Also, scientists, would like to study the mechanism of self diffusion in liquid metals in gravity free region as diffusion and gravity convection cannot be told apart in the laboratory, under normal gravity

The spacelab investigations in life sciences will include among other things response of the human body to weightlessness, immune response of crew members before, during and after flight, examination of the growth of sunflower seedlings in the absence of gravity a study of the circadian rhythms of a fungus in an extraterrestrial environment

Birth defects: What is the solution?

A NEWBORN baby is a thing of beauty, but when birth defects scar the child, what can parents do? Birth defects occur in four out of every 100 live births in India, according to P Upadhyaya, Head of the Department of Paediatric Surgery at the All India Institute of Medical Sciences New Delhi This means about 150,000 Indian infants are born with malformations and defects

every year. The defects range from those serious enough to cause death within 48 hours after birth, to those which are just plain embarrassing like cleft lips or monstrosities. They may be external malformations or internal defects involving the kidneys, heart, lungs or other organs.

Birth defects can result due to genetic abnormalities like chromosomal aberrations or because of external influence on the developing embryo. What causes these abnormalities? Various factors including hereditary make up and mutagenic agents are responsible. Mutagenic agents are factors which cause an alteration in the normal genetic or hereditary structure of a living being. They include radiation, exposure to chemicals, drugs, alcohol consumption, cigarette smoking and certain infections like German measle which affect the mother during pregnancy. The foetus is most vulnerable during the first two months of pregnancy.

Older mothers and parents with a family history of genetic abnormalities are more likely to have babies with defects. But this does not mean that the affliction cannot be detected and corrected. It is possible to diagnose certain defects before the baby is born by amniocentesis and ultra-sound scanning of the uterus. In amniocentesis, fluid and foetal cells are withdrawn from the uterus of pregnant woman. These are then tested for abnormalities. Ultrasound scanning uses sound wave projection to test for abnormalities in the foetus. This method has the advantage of being non-invasive—it does not directly interfere with the foetus. For example, congenital obstruction in the kidneys can be diagnosed by this method and surgical correction can be made a few weeks after birth to prevent kidney damage. If detected early enough many birth defects can be treated soon after birth and the child could thus get a new lease of life.

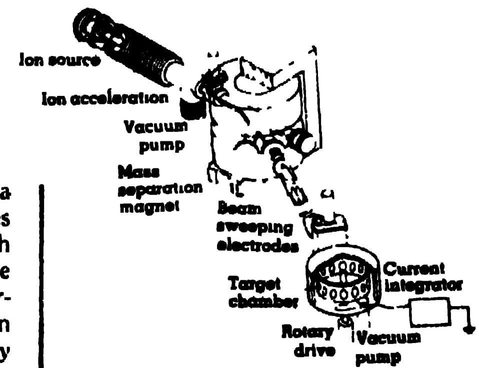
Early treatment for birth abnormalities could give a new lease of life to children

Long live the hip joint

THE artificial hip joint that we are talking about is essentially a metallic ball which moves in a polyethylene socket. Since metals and alloys are highly prone to corrosion it is really a disadvantage to have them housed inside the body.

Corrosion resistance, electrochemical behaviour, coefficient of friction, bonding ability are all properties of a solid, controlled by a thin slice of surface layer whose thickness is just a few micrometers. Metals and alloys are normally protected from corrosion by a layer of oxide which forms on their surface. If this oxide film starts wearing off then corrosion starts setting in. In the hip joint this protective layer gets damaged by the continuous rubbing of the ball against the socket. When this happens the body fluids can attack the bare metal and undesirable metal ions can get into the body.

Ion implantation, a technique widely used in the semiconductor industry is proving useful in extending the life of certain metal and alloy surfaces. This technique, as the name implies, consists of bombarding the target with selected ions. In many cases, it is found that the implanted surface has better corrosion resistance.



Apparatus used for ion implantation

It is recently reported that material scientists from the US. have been able to modify significantly, the surface properties of the alloy used in the artificial hip joint through the same technique. They claim that the wear rate of the treated ball-socket joint is 400 to 1,000 times less than the untreated. So, the artificial hip joint now, will last a lifetime.

Star wars aren't far off

THE USE of antimatter beams for shielding and extraterrestrial resources as platforms for ballistic missile defence were considered by the Defensive Technologies Study Team headed by James C. Fletcher, former administrator of the National Aeronautics and Space Administration of the US

Extra terrestrial resources considered for use are materials from the moon and near-Earth asteroids which could be utilised to provide large amounts of mass in the Earth's orbit for such purposes as shields and high inertia platforms. These could be brought down to the Earth's orbit more easily than launch them from the Earth's surface.

With regard to directed energy concepts, especially those involving particle beams, the technology thought of was deposition of substantial energy at depth in a target. Thus the beams become highly lethal. It becomes almost impossible to shield against them.

Another consideration was of a space-based particle accelerator that could accelerate antimatter rather than normal matter. Antimatter, when it interacts with normal matter, the latter is annihilated, resulting in a complete conversion of matter into energy.

Plug into the wall and charge off

THE next time your car needs fuel try plugging it into the side of your house. Or raid the rubbish at the bottom of the garden

Crazy? Not at all Scientists around the world are constantly coming up with new ideas for sources of fuel to replace conventional oil-based petrol for the family car

Plastic, paper, potato peelings, used tyres, sugar-beet, artichokes, salad oil, sunflower, peanuts and palms .. they are all under consideration.

Even the water of the oceans is a hope

It is all part of the race to save the world's dwindling oil stocks And among the respectable runners in that race is a car which will be able to run on natural gas and will be refuelled by plugging into the household gas supply. The around-the-town car that uses methane or natural gas, will also be adaptable to run on ethanol, methanol or liquid petroleum gas

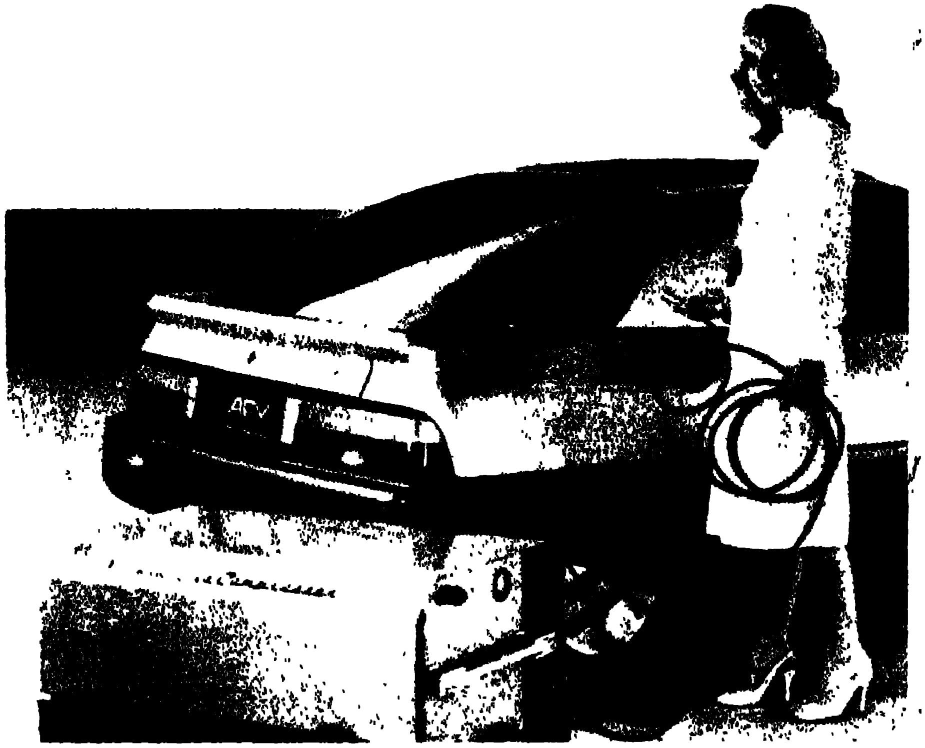
In Manchester, northern England, the university's Institute of Science and Technology, under the direction of two scientists, Noel McAuliffe and Roger Benn, is converting garden and dustbin rubbish, including plastic, paper, potato peelings and textiles into crude oil at the rate of almost three barrels a day.

If you have looked upon used tyres as only suitable for playthings for children, think again

That is the advice of Ken Griffiths, managing director of Leigh Interests in Wolverhampton, English midlands in the UK He is overseeing the world's first commercial-scale plant to produce oil, solid fuel and scrap steel- from used tyres.

He says "The plant will be at full capacity by 1984 It aims to produce 20,000 tons of high calorific oil a year and there's no sign of the corrosion which fuels from alternative sources to natural oil often produce'

In Brazil, they turn out 18 million litres of alcohol -enough to keep an alcohol powered family car going for 145 million kilometres. Brazil aims to have at least 20 per cent of the country's vehicles running off on alcohol by 1985 Last year, there were some 400,000 alcohol-powered cars on the road



The car is fuelled with compressed natural gas. Compared to an electric car it is cheaper to run and has faster acceleration

A whole range of alcohols were envisaged as a substitute, opening the way to the eventual use of vegetables and vegetable wastes—the so-called biomass industries—which were a significant energy source in France

The industry ministry of France said that "carburol" (France's name for gasohol) would be produced by a technique using enzyme catalysts on a wide variety of vegetable matter Alcoholic fuels can be derived from substances like coal, wood, corn and even artichokes

The West Germans reckon they have done better than anyone by taking a searching look at the Elko engine which is now being tested in a wide variety of cars and could be on the European market next year

The unit, which is miniscule compared with ordinary, bulky oil burning engines, is reckoned to be 20 per cent more economic than a diesel and does not need a conventional cooling system or radiator The power is derived from the rape plant, a bright mustard yellow crop from whose oil cattle cake is made. If cattle cake turns out to be in short supply then the unit can burn any other kind of vegetable oil, from salad to sunflower

And, talking of sunflower, owners of lorries, vans and farm tractors could be running diesel engine vehicles on it. Enough oil can be obtained from the sunflower crop of one field to fuel a tractor ploughing ten fields of similar size

John Bockris, head of hydrogen research at the Texas Agricultural and Mechanical Institute, in the US, claims "an important breakthrough" in the perennial search for an alternative fuel to oil—his team has opted for a solar-powered process that can extract hydrogen fuel economically from water

Water is a compound of hydrogen and oxygen the trick is to separate the two by a process known as "electrolysis".

Until recently, the Texas team had only been able to produce between one and five per cent of hydrogen from a given amount of water But a new method meant that 12 or 13 per cent could be produced

Bockris explains: "This could mean eventually that hydrogen fuel, which is now too expensive to produce commercially, could become as cheap as oil It could do everything now undertaken by oil—like running cars, powering factories, heating homes—except act as a lubricant. An aircraft with its tank full of hydrogen fuel would be able to launch a much greater weight than at present because hydrogen itself weighs so little."

Bockris has agreed that his "fuel from water" scheme is for the next generation. He points out: "But that's not far off What it means is that by early next century the US will have converted to hydrogen fuel from its present dependence on imported oil."

—Carlton Stuart

(Asia Features)

The case for an integrated, "holistic" biology

ONE OF the most striking images of our times is the picture of the Earth taken from space: a wondrous patch-coloured globe, wreathed in an occasional cloud suspended precariously in the vast void, home to millions of life-forms startling in their variety and fecundity.

The Gaia hypothesis encourages us to regard the entire Earth as one vast organism. Lewis Thomas, the best-selling author of *"Lives of a Cell"* and *"The Medusa and the Snail"* has compared the whole Earth to a single living cell. The writings of Thomas point to numerous symbioses and to that marvellous web of inter relationships by which life is sustained. Peter Medawar (the Nobelist) and Jean Medawar's *"The Life Science"*, less lyrical but equally stimulating, conveys some of the excitement in the wide-ranging perspectives of today's biology.

At a recent symposium celebrating the 30th anniversary of Watson and Crick's paper on the double helix, "honest Jim" Watson wondered how any bright young mind could fail to plump for molecular biology as *the* field of choice. The deserved success of molecular biology, genetic engineering and recombinant DNA techniques hit our headlines regularly. Nevertheless, in the long run, nature would have to be more than useful material for molecular insights and clever manipulations. Ecology and, more generally, environmental science is just beginning to open up a marvellous awareness of the intricate connections and feedback loops which sustain man, plants, animals, microorganisms, soil, air, river, ocean and the Earth's renewable resources. In the ocean alone we are faced with one of our least known and most wondrous mysteries.

There might also be other brilliant young minds whose preference might incline to the inter-disciplinary neurosciences rather than to the mechanicism of recombinant DNA techniques or (really the other extreme!) the hierarchic complexities of ecology. The whole pattern of evolution can be interpreted— and Teilhard de Chardin has done just this — as a thrust towards a noosphere and the dominance of a central nervous system which, given modern technologies of communication, are drawing us to Marshall McLuhan's "global village". Maybe, therefore, the field to work in would be the "brain-consciousness" interaction.

It is interesting that Roger Sperry (Nobel Prize, 1981) is now mounting a strong attack on superficial reductionist paradigms in biology on scientific grounds. He claims that his split brain research and related investigations favour "mentalism" and downward causation: the upper levels of consciousness bringing about molecular effects. In simple terms, if it is true that drugs affect the brain, it is equally true that the brain can control that screwed up body chemistry which makes the drugs necessary.

To sum thus far, I have tried to suggest where biology today is at: ranging widely over the whole Earth— to the molecular mechanisms of all living things and through the neurosciences to the problems of consciousness, medicine and moral values. Here is one vast, connected panorama to delve into scientifically with the help of the unifying insights of evolution, molecular biophysics and biochemistry, ecology and genetics. There is also individual morphogenesis and development and for those mathematically inclined, statistics applied to developing populations.

I am not saying that the more specialised study of animals or plants or microbes as separate disciplines is not good or useful biology. I am saying that an integrated approach is surely at least as good, at least as necessary and at least as true to the richness and complexity of today's best biology. Against the background of the idea of integration, as expressed above, a "Life Science" course has been constructed in the University of Bombay.

In most countries, at the undergraduate level, biology is taught in an integrated fashion (taking in all life forms together, under their unifying concepts). Hence, it is a surprise that, except in the University of Bombay, there seems to be no serious attempt to introduce integrated biology or "Life Science" into the undergrauate courses at our Indian Universities. And this despite the clear recommendation, more than ten years ago, of a Binational Conference on the Teaching of Biology organised by our own University Grants Commission.

Today biology ranges widely over the whole Earth, to the molecular mechanisms of all living things, through the neurosciences to the problems of consciousness, medicine and moral values

Actually it is possible to teach botany or zoology or microbiology in such a way that integration becomes central. It is refreshing to see that some of the better minds in our best university departments are on that kind of track. The universal appeal and success of David Attenborough's *Life on Earth* series is an indication of how fascinating animal life can become when put into its natural context in a connected way. (But does such integration go far enough?)

Resistance to integration?

On the other hand, there is little doubt that any integration in biology is being resisted in most of our universities. Why this should be so? Among the reasons often cited are: inbuilt distaste for change, unwillingness to make the necessary effort to update one's teaching, entrenched power-blocs, need to protect one's own field or ensure employment for one's own students, etc. The reasons, could be hurtful and, in any event, they are difficult to evaluate. Hence I prefer to deal with the resistance on possible academic grounds.

Perhaps the most incisive argument against the integrated approach is that by trying to do too much it does little or nothing. This kind of argument can best be weighed on the relative quality of the B.Sc. students produced. The criteria should be objective and applied in an objective way by individuals or agencies not personally involved. At present, the Life Science B.Sc.'s of Bombay University score comparatively excellent grades in the "G.R.E. Advanced" Examination. If the "G.R.E." is rejected for being a "foreign" test, it still remains an objective, outside evaluation of biology in all its aspects. We are told that a similar examination is being planned for India and can only look forward confidently to accepting the challenge of that.

It hardly helps to say "Life Science has no scope", if the unsuitability of an applicant for a given post is automatically linked to his having taken a Life Science undergraduate degree, rather than one in Botany or Zoology or Microbiology. There is an obvious and unfair vicious circle in such a procedure. Every case for a biology post needs to be evaluated objectively

OF SCEPTICS AND SCOPES

Prabha Srinivasen

WHAT has Mount Palomar's giant telescope in common with the sceptic who scoffs at the system? They share an etymological root— Greek *skeptomai*, which means to consider or to look at. Whether you use the telescope to bring the galaxies closer or use an electron microscope to watch the dance of atoms, the instruments which give you these views (or scopes) are extremely important tools of science—the very eyes and ears of scientists as it were. Given below are ten of these fascinating instruments. Can you guess what they are used for? **Answers on pages 74, 75.**

(1) Oscilloscope:
(A) Uniform movement of pendulums
(B) A device to represent electric signals.
(C) A submarine periscope that resists oscillations

(2) Ebullioscope:
(A) Device to measure boiling points of solutions
(B) Measure for counting particles in an emulsion
(C) Device for deep examination of the eyes

(3) Spectroscope:
(A) An ESP meter that "reveals" spectres
(B) Study of radiation emitted by substances
(C) Three dimensional cinema

(4) Electroscope:
(A) Device in electrocution
(B) A lightning conductor
(C) Device detecting electric charge

(5) Stroboscope:
(A) Device used for study of under water plant life
(B) Machine to record periodic motion
(C) Lights for discotheques

(6) Cinemascope:
(A) A special effect in movies
(B) A device to project 35 mm film on a large screen
(C) Device for editing films

(7) Koniscope:
(A) Measures the apical angle of a cone
(B) Device used in submarines
(C) A device to check atmospheric dust particles.

(8) Fluoroscope:
(A) Used in flour mills to see particle size
(B) Used for X-ray examination of patients
(C) Used by aircrafts for night flying

(9) Aerobioscope:
(A) Used for purifying air for scientific purposes
(B) The device used to study the wing muscle of airborne birds
(C) To determine the bacterial content of air

(10) Laparoscope:
(A) Used to visualise the abdominal cavity
(B) Used for early detection of leprosy
(C) Used to study the lapping of waves at high tide

'Holistic" biology

according to what the individual candidate is expected to do or teach -that would be to give each one and biology itself a fair chance

Another argument is that integration is better achieved at the postgraduate rather than at the undergraduate level. There is merit in this view but those, like me, who feel that it is better first to consider the whole may also have a good point. In our approach, the "holistic", vision is paramount to first synthesise the best of today's biology precisely in order to bring (later) a variety of ideas from many angles into the detailed consideration of any part"

A third argument is that teachers will need to be re-trained. Yes, of course! And the experience of the fine group of teachers in the four Bombay colleges shows that with patience, persistence and goodwill this re-training has been, by and large, a real success. We enjoy working with each other learning from each other's strengths and supplying for each other's deficiences. Each of us had earlier specialised with the Botany, Zoology or Microbiology streams but it is fun learning to teach "Life Science" and student response is good.

Finally, it could be argued that several types of undergraduate 'Life Science" syllabi could be constructed leading to all kinds of integrated courses of quite diverse quality. True enough! One has to pick, choose and balance the different sub-fields. This makes it all the more necessary for academicians and professionals to evaluate, in a positive manner, our Bombay University experiment and help us with their encouragement and criticism. We are open to all good ideas from any quarter.

On the 19th 20th and 21st January, 1983, the Life Science students of St. Xavier's College, Bombay, put up an Exhibition (in the College) on what they were studying. The teachers of St Xavier's and the other colleges helped. The undergraduate courses were the main focus but some of the postgraduate courses (Biotechnical Science and the Neurosciences) were also described. One of the exhibits presented the data from an integrated study on the quality of ocean waters around Bombay, funded by the Nehru Centre. This was achieved through the combined efforts of staff and students from the Departments of Life Science (mainly!), Chemistry and Geology assisted by the Caius Laboratory for Inter Disciplinary Research.

We feel we have begun something worthwhile but that have still much to learn and far to go. All suggestions and criticisms from the readers on the thoughts expressed in this article will be warmly welcomed.

Father Lancy Pereira

Fr Pereira is the Director of the Caius Research Laboratory of the St Xavier's College, Bombay and a member of the Life Science faculty. Along with others he was instrumental in introducing the new Life Science syllabus in the Bombay University.

The Leather Landscape

K. A. Ramasamy K. S. Jayaraman N. Ramanathan

"I'LL tan your hide," says Aristophanes in his play *The Knights* (424 B.C.). Puns apart, the father of Greek tragedy knew what he was talking about—tanning is one of the main processes which converts "raw" hide into "durable" leather.

Leather making is probably one of the earliest arts practised by man. Ice Age Man wore animal pelts to protect himself from the biting cold and preserved specimens of leather from 5000 years B.C. have been found.

The leather-making of primitive Man was a race between his efforts and the destructive forces of nature. Scraping the skin with flint knives to free it from flesh was probably the only operation carried out by the primitive hunters. Sun-drying of such skins prevented immediate decay but produced hard hides (like the bear pelts displayed by some of our roadside quacks). To soften them, salt and animal fats were used. Smoking was also employed to prevent decay. Gradually, however, the ancient peoples— Sumerians, Egyptians, Indians and Chinese, mastered the art of tanning; that is, treating the hide with an agent which displaces water and then joins and coats the collagen fibres in the skin to impart resistance to heat and decomposition caused by water and microorganisms. The tanner became a skilled specialist and the skills were passed from father to son.

The leather industry today may be regarded as a bridge between the production of the hide as a by-product of the food industry and its manufacture into shoes, garments and a host of other goods for which it provides a basic raw material.

The production of leather is a long complicated process and certainly not one which can be embarked upon successfully without specialised skills. We can say tanning is not only a science but an art. Before one turns to tanning, it is necessary to understand the histology of hides and skins. (Large animals are said to have "hides" while smaller animals like the goat, sheep and rabbits have "skins".)

The hides and skins of mammals can be divided into three distinct layers depending upon their structure and origin. They are: (1) the epidermis formed by a thin layer of epidermal cells, (2) the dermis or corium consisting of a thick layer of cells, and (3) the subcutaneous adipose or flesh layer. In tanning, the epidermis and the fleshy layer are removed and it is the corium which is tanned into leather.

Sixty to seventy per cent weight of a fresh hide is water: while proteins form 30 to 35 per cent of the bulk; the balance is made up of about 2 per cent lipids, 0.5 per cent carbohydrates and one per cent mineral salts and other substances like pigments. In a dehydrated condition, 90 to 95 per cent of the hide is composed of proteins, both fibrous and non-fibrous. Of the fibrous proteins, the most important is collagen which accounts for nearly 85 per cent of the corium. The non-fibrous proteins are albumins (water soluble), globulins (soluble in salt solutions) and mucins, mucoids or glycoproteins (soluble in dilute alkalies).

Curing and preservation

The chemical composition of raw hide makes it liable to attack by micro-organisms which decompose or putrefy the tissues and eventually render them unsuitable for manufacture of quality leather. Curing is the name of the treatment followed to prevent the attack of these organisms. Curing must not change the condition of the stock to such an extent that it cannot be brought back to its original fresh condition by simple processes like washing and soaking. In a well-cured hide the fibrous structure must neither

Simple drying and salting are the two important methods of curing which can also be achieved by radiation, freeze drying, brine and dry pickling

be damaged physically or chemically. Nor should its interfibrillary proteins undergo any permanent change. Perfectly cured hides can be stored for a long time

Simple drying and salting are the two important methods of curing. Besides these, freeze drying, curing by radiation, brine curing, curing by pickling, dry pickling are also available.

Pretanning operations

Soaking—the process before they are taken for liming— is carried out to soften the hides, to remove the adhering salt, blood, dirt, etc and to produce a light swelling and to bring the hides to the original condition by rehydrating the fibres. Fresh and wet salted hides and skins can be easily soaked, but dry ones require longer time. Sodium sulphide and sodium hydroxide along with wetting agents may be used for speeding up soaking. Addition of bactericides is important to control the growth of micro-organisms

Liming is the next process, it loosens the hair, swells and plumps the fibre structure, separates the individual fibre structure and opens the fibrils, natural fat is saponified, unwanted proteins such as sweat glands and blood vessels are removed (as is flesh). Liming also helps bating and leads to greater reactivity of the skin protein. Slaked lime, sodium sulphide, sodium hydroxide, sodium hydrosulphide, arsenic sulphide, amine salts and even enzyme products are used in different liming processes. 60 years ago lime alone was used. It is still used for liming light leathers. The soaked hides or skins are spread flesh side down on the surface of the lime liquor. No skin must show above the surface of the liquor or there will be formation of "lime blast

Each day, the skins are hauled. Normally liming takes 10-15 days. The hair may loosen but this is not always the case. Only used lime liquors which contain amines act as dehairing agents and help in removing the hair. The age-long practice is to commence the work in a pit containing used lime liquor to which some lime and sodium sulphide are added. After 3-4 days the liquor is drained and a new lime liquor is prepared and sometimes this is usually strengthened with soda ash which increases its swelling and plumping effects. The hides are processed in this liquor for 4-5 days and taken out for unhairing and fleshing. A three-pit system having old, medium and fresh liquors was also popular earlier. It has now been replaced by short liming processes using "sharpening agents" like sodium sulphide which increases hair-loosening action, plumping, etc. This is employed in processes like paint liming, drum liming, pit liming

of dog dung (puer) or pigeon guano. Bating is mainly due to the enzymic action on the pelt. Bating is normally done in a few hours in case of cow hides meant for upper leather of shoes. The hard natured goat skins take much longer time. Bating not only loosens the collagen structure but also breaks down the fat cells and thereby removes natural grease to a certain extent from the pelt. The hides are partially delimed and the bating is performed in lukewarm water (38-40°C). The practice of bating, the amount of bate and the time of bating varies with the type of

Del iming

Deliming removes the alkalinity from the hide either partially or completely according to the type of leather required. By simple washing, the unfixed lime is removed. The residual lime is found combined with collagen and some acids like hydrochloric, lactic, boric or acid salts like sodium bisulphite, ammonium sulphate or chloride are used to remove it. Deliming can be done in pit, paddle or drum

Bating

Bating is a step in the purification of the hide prior to tanning. "The chemical called a bate is used to remove the unwanted components consisting of protein degration products, epidermis, hair and the scud on the surface of the skin, in the hair follicles and pores and some of the chemically resistant fibrous proteins. In old days, bating was called pueiring and referred to a treatment of the pelts with a warm infusion

raw materials used depending upon the final derived product

The bated skins should be flaccid, soft and slippery to the feel and should retain the impression of the thumb when pressed. It should be possible to squeeze air through efficiently bated sheep and goat skins. The scud, dirt or pigment should be loose and be easily scraped out of the grain side of the bated pelt.

Pickling

Pickling is a process by which the hides/skins are treated with salt and acid solutions. Pickling is usually performed after deliming and bating operations. It is an essential prior step to mineral tanning (to bring the pelt to an acid condition so as to prevent the precipitation of insoluble chromium salts on the skin). Sulphuric acid and common salt are normally used for pickling. Sometimes organic acids are also added. Pickling is mostly done in

The entire science of leather manufacture is the science of skin proteins and their interaction with acids, bases, salts and organic and inorganic tanning agents

drums. In general, pickling could also be done prior to vegetable tanning. This results in a cleaner pelt. Pickling removes stains caused by sulphide and iron. Pickling is also done to preserve the hides for storage and for export. Pickled skins will keep indefinitely if protected from water and moulds. When allowed to dry out, the pickled pelt is soft and leathery. Some preservative is also added during pickling.

A zebra being skinned. Leather can be made from all sorts of animals ranging from aardvarks to zebus; cattle, goats and sheep skins account for the bulk of the world's leather supply.

Depickling

By depickling, the pickle acid is removed for which the pelts are treated with mild alkali. Depickling is essential prior to vegetable tanning.

Tanning

After the pretanning operations, the hides/skins are taken for tanning. All soluble protein is removed before tanning. In a hide the fibrous collagen proteins over bonded chains which can be broken down by heat or hydrolysis into glue or can be strengthened by tanning into leather. The entire science of leather manufacture is therefore the science of skin proteins and their interaction with acids, bases salts and organic and inorganic tanning agents. leathers. Synthetic tanning oils like sulphoclorinated mineral oils are used for chamois type of leathers.

Among the mineral tanning agents, chrome salts are the most important. Sodium dichromate is reduced by means of reducing agents which may be either organic or inorganic. The basic chromium salts are used in one bath chrome tanning process. In two bath tannage, the pelt is first treated with dichromate and acid and then reduction is brought about subsequently inside the pelt by hypo. In recent years, chrome tanning process has been rationalised. The powder tannage or floatless tannage is very widely used nowadays. Another improvement effected in powder tanning is the self-basifying tanning system.

Aluminium tanning is one of the oldest methods known but this is not a stable tannage and the hydrothermal stability obtained is very low. The leathers are not stable to cold water-washing and some of the fixed aluminium salt gets stripped.

Recently zirconium salts are finding wide application in tanning. Zirconium tannage gives thorough white and well-filled leathers with fairly high thermal stability. The leathers have good buffability and possess good nap for finishing suedes.

Vegetable tanning

Vegetable tanning consists in treating the pelts with infusions of barks, leaves, fruits, nuts and also roots of various plants. These infusions contain a characteristic chemical compound, phenolic in nature, which is generally termed "tannin". These combine with the proteinous matter of hide and make them resistant to the action of enzymes and water and impart thermal stability. The vegetable tannins are broadly classified into "pyrogallol" type and "catechol" type. These are astringent in character, they possess the property of dehydration and contracting the protein fibres.

In vegetable tanning, the pelt is not allowed to come into contact with the highly concentrated liquors of tanning since the protein has a very great affinity for tannins. The tannins combine immediately with the protein (skin). With the high fixation of tannin on the surface layers of hides further penetration is prevented. A drawn grain results as a consequence. So it is always advisable to start tannage at low concentration of tannins. In the modern method of vegetable tannage, attempts are made to reduce the time of tan-

nage. This has been made possible by the introduction of "syntans" to quicken the penetration of tannins and the use of drums for tanning instead of pits.

Formaldehyde tanning

Formaldehyde tannage produces a white leather which is empty. Normally this is used in combination with other tanning materials The grain surface of a skin becomes rough. The main characteristic of a formaldehyde tanned leather is its ability to recover area after thermal shrinkage. This tannage is very quick because of the low molecular size of the tanning agent

Oil tannage

Oils like cod oil and sardine oil are able to tan because of their chemical structure and oxidation products derived. The tanned leather is called chamois leather which possess high water absorption, is soft and has a cloth-like feel. The hydrothermal stability of chamois leather is rather poor. The tannage consists of treating the pelt in fish oil and they are hung up in a room of relatively high humidity and at a temperature of 45-50°C. The oxidation process evolves heat and as a result changes in the fibre structure are brought about

Combination tannage

A particular tannage may lack an important property which may be the strong point of another tannage and the combination of the two may impart the good qualities of both to the leather, minimising the undesirable qualities of either of the tannages. Combination tannage not only influences the final property of the leather, but also may help in reducing the duration of tanning. For example, the outstanding characteristics of chrome tanned leather is its excellent heat resistance, fine grain and internal spring. But it lacks in tightness of grain and is also rather empty. By retanning full chrome leather with vegetable tannins, the break of the leather and its fullness are improved.

Different surface finishes

The process of dyeing and finishing varies depending upon not only the demand of the buyer but also on the method and material of preparation. For example, the technology of dyeing and finishing of glove leather is entirely different from that of shoe upper leather.

Dyeing

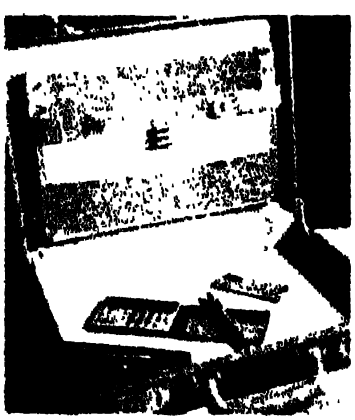
Dyeing is essentially done with three objects in view: dyeing of aniline, dyeing of suedes and dyeing to be followed by a coat of pigment finish. Because no covering coat is given for suedes, dyeing is of great importance. Similarly aniline uppers which are finished without any pigment should be dyed to level shades. As leather is made of a three dimensional weave of fibre bundles, penetration of dye into their matrix assumes importance. The dyes that are used in leather industry are acid dyes, direct dyes, basic dyes and premetallised dyes. In dyeing operation, certain auxiliaries are used to achieve penetration of dyes, fixation of dyes and improvement of bleeding fastness in water. Sometimes dyes are fixed using cationic dye fixatives.

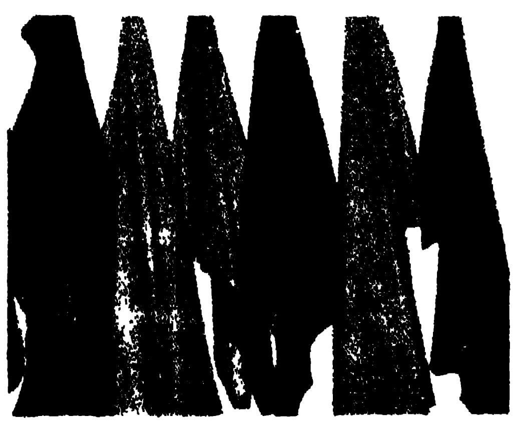
Finishing

Finishing is perhaps the most vital part of leather processing as the final product is judged by its appearance or handle. Whatever faults that have occurred during the earlier processing can be corrected by finishing. In finishing, there are two basic approaches: one involves the use of protein finishes followed by glazing and in the other resin finishes are invariably used. While the protein finished leather has a natural appearance, elegance, feel etc. the resin finish imparts its own characteristic plastic handle to leathers.

Protein finishes

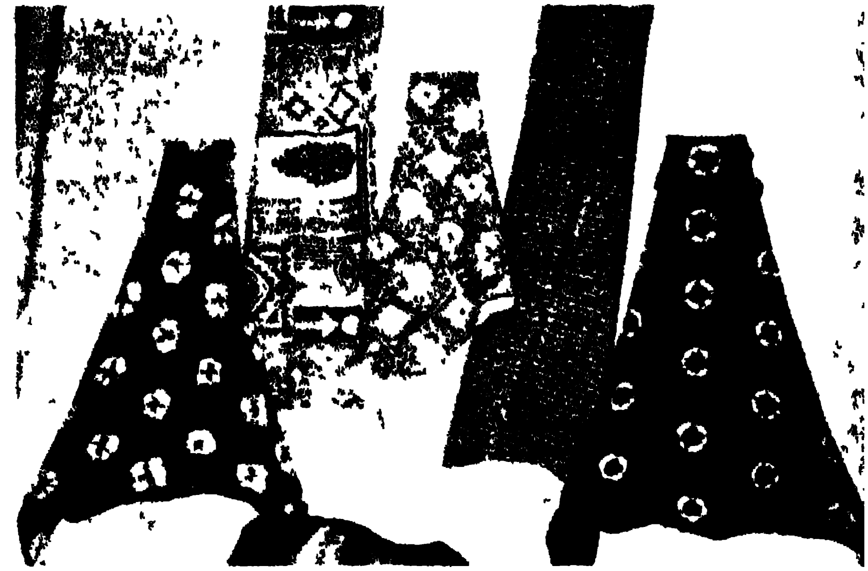
The basic principle involves in protein finishing is to apply a coat of some hard proteinous material which under friction and heat produces a lustrous appearance. Casein, egg albumin, blood albumin and shellac are some





KARIM ESMAIL STORES DHABU STREET, BOMBAY

But for the intense cultural taboo involved, human skin is like any other...Perhaps frailer than the striped coat of the tiger or the spotted glory of the leopard



such materials Gelatin is often used in small quantities for improving the gloss of the finish to the leather Other adjuncts are small quantities of wax which help in glazing and thickeners like gums mucilages and carboxymethyl cellulose to increase the viscosity of the finishes so that penetration is controlled In addition, dyes are used to improve the tonal beauty of the finish

Resin finish

Resin finishing is of interest to tanners who cater to the domestic market as well as export market Resin finishing technique is simpler than finishing with protein compositions A composition of pigment suitable thermoplastic resin wax emulsion dye solution and water and sometimes a little quantity of ammonia in required percentages is used for resin finish Generally the practice is to give one or two coats of finish by brush followed by 2 3 coats of spray Then the leathers are dried and plated after spraying with a lacquer emulsion or casein-formaldehyde Artificial grain or cow grain or hair cell grain is usually printed after the pad coat For full grain leather this is not done, often 2-3 platings are done in between the pad and spray coats Polyurethane finishes are very popular nowadays because they produce results unsurpassed in performance □

Of scalps and souvenirs

DURING the course of their violent past men have sometimes flayed and tanned the skins of fellow human beings For grisly as it seems human skin can be processed like any other skin or hide! References to the use of human skin abound both in mythology and history Apollo is said to have flayed Marsias for adultery and kept his skin in the city of Celina

As said earlier but for the intense cultural taboo involved human skin is like any other perhaps frailer than the striped magnificence of a tiger skin or the spotted glory of the snow leopard's coat The process itself is quite simple Treated human skins are taken and put in a bath 900 gm of common salt some 100 gm of Vetriolo acid 250 gm of aluminium salt are added to the bath and it is dissolved in 2 litres of boiling water Then the skins are handled and left in the bath for 24 hours Thus are human skins tanned!

In times past such processed human skins were used but never for trading purposes Although there are instances of human skins being used for the manufacture of leather goods and book binding particularly The historian Herodotus wrote that he had personally seen objects made out of human skins In those days a man who possessed the maximum number of horse saddles made of human skins was considered most valorous Herodotus further wrote that the Persian King Cambise (528 522 B C) had one of his corrupt judges executed, his skin was peeled off and put on the King's couch During King Artiasere's reign not only corrupt judges but also those who delivered inequitous judgements were similarly punished In his Souvenirs by Pierre de Courshamp states that a Frenchman by name Philip Egalte wore pants of material made out of human skins!

With the progress of civilization laws were promulgated forbidding the defilement of the dead in any way However in 1945 46 during the historic trial of war criminals in Nuremberg episodes came to light of treated skins being found in the house of Captain Koch Head of German Concentration Camps at Buchenwald He was prosecuted and condemned

Articles made out of human skins have been found only in Libraries Museums and Palaces

Recently an unverified report in a Tamil Weekly stated that one Basavappa of Basaveswara in Karnataka, aged 35 offered a pair of chappals made of his own skin to a temple in Pakawadi near Basaveswara It is stated that he cuts his skin in small pieces and made these chappals

TEST-TUBE LEATHER

MANKIND'S demand for leather is too great to be fulfilled by natural resources; hence many types of synthetic leathers are now being produced for a variety of applications in footwear, upholstery, garments and luggage.

Of these, footwear is the most demanding in terms of strength, durability and flexibility of material. Also it needs to be endowed with the ability to absorb and dissipate moisture during use to provide comfort and hygiene.

Cheap leather substitutes came on the scene in the 1920s—these "oil-cloths" and "leather cloths" were followed by the introduction of vinyl-coated fabrics in the 1940s. These early inventions were no match for leather for they cracked too readily when flexed and had a short life. Moreover, none of them were permeable to air or water vapour. Since the 1950s newer alternatives with more satisfactory properties have been introduced. These can be broadly classified into two categories. Poromerics which try to reproduce all the desirable qualities of natural leather including its "breathability" and other ersatz leathers which merely reproduce the same visual effects and "handle" or feel as that of natural leather. These are mainly plastic (or polymer) coated fabrics.

Poromerics

The DuPont Corporation in the US introduced the first poromeric, Corfam in the early 1960s. Despite its many excellent properties it was not commercially successful initially. With subsequent developments it has now gained worldwide usage.

Leather itself is almost entirely composed of densely tangled bundles of hydrophilic (water absorbing) protein fibres known as collagen. These fibres are more tightly matted near the upper or "grain" surface than on the flesh side. This structure gives great strength, together with permeability to water vapour and air, and the ability to flex without much wrinkling of the grain surface. Certain plastic foams show similar properties but absorb moisture less readily, pelts or "non-woven" fabrics have good strength properties but do not readily accept lacquers or finishes to give a good aesthetic appearance.

Corfam had a complex structure, comprising a non-woven felt backing on to which was laminated a tightly woven nylon cloth. The top surface was polyurethane foam, which permitted the passage of water vapour and would accept lacquers and polishes. The felt layer was made from a needle punched web of polyester fibres, which was impregnated with a polyurethane solution to bind the fibres. The woven nylon fabric was bonded to it with a polyurethane adhesive. The polyurethane foam was cast on the surface, and the desired visual effect was applied to the surface by pressure from a heated plate engraved with the desired leather-like grain pattern ("plating"). A final lacquering operation gave the desired surface finish.

Commercially successful poromerics range from an entirely fibrous material (for instance Tanera) to an all foam structure (such as Porvair). Tanera is produced by controlling the needle punching to give a material with a greater degree of entanglement on the grain surface than on the reverse side. The fibres are then lightly impregnated with a polymer solution which acts as a binder.

Porvair, on the other hand, remains the only poromeric which does not contain fibres of any type, and was the first poromeric to be produced in Britain. It is a reticulated polyurethane foam, that is, it has many pores which interconnect throughout the body of the material. It is produced by dissolving the chemical constituents of the polyurethane, an isocyanate and a polyol, in a suitable solvent (dimethyl formamide) and dispersing finely powdered salt (sodium chloride) into the reaction mixture. The resulting material is then cast in two stages on to a moving flexible wire mesh belt.

The first layer has a coarse texture, and the second, finer layer is cast on top of it. As the polyurethane 'cures' or sets, the residual solvent is removed and the salt is leached out by washing in water. This is done by passing the continuously cast sheet material over rollers which lead it through a series of water tanks at controlled temperatures to remove the salt. The material is then dried and finished by plating and lacquering in the same way as for Corfam.

Clarino, a Japanese poromeric, and Xylee, from West Germany, are both intermediate in structure between Porvair and Tanera, that is they both use a polymer impregnated felt substrate on to which is cast a polyurethane foam. In the case of Xylee, careful coagulation of the foam during its formation produces the low density reticulated structure necessary to give permeability to water vapour.

All these materials are able to absorb moisture and to dissipate it through the grain surface, which is particularly important in footwear applications. Only a small amount of poromeric material is used in other less demanding applications, in which the cheaper coated fabrics are often equally satisfactory.

How do poromerics compare with leather in performance? Any material used as an "upper" (the portion above the sole) in footwear must have sufficient strength to withstand pulls on the last (last is a metal or wooden model used by the shoemaker to mould his product from processed leather). The material should also possess a balance of plastic and elastic stretch to enable the upper to conform to the shape of the foot also of the last *without* becoming progressively loose and shapeless. Leather has all these qualities. But poromerics have a tearing strength well below that of leather. Their tensile strength is also low. Moreover, leather has a more uniform stretch at various directions than that of poromerics.

Leather can be easily "lasted" at room temperature. Sixty-five per cent of the basic shape is "set" when the leather is left on the mould or the last for three days and allowed to recover for 24 hours. Under identical conditions, poromerics show only 30 per

CLRI's leather largesse

THE Central Leather Research Institute, which is one in the chain of National Laboratories under the CSIR, was established in the year 1953. The main objective of the Institute is to develop appropriate technology and transfer it to the leather industry: also to build up technical manpower through training programmes. Developing know-how for the different sectors of the Indian leather, footwear and leather goods industries is also one of the main goals. The task of transfer of technology is extremely complex since the industry is age old and exists at different levels, namely, village, small middle and large scale sectors.

During the last 30 years of its existence, the Institute has had a number of major achievements to its credit.

CLRI has concerned itself with the processes of both traditional and newer types of leathers. Bag tanned leather at the village level and E I tanned leather at small scale level are examples of the traditional types of leathers. The modifications made in bag tanning are such as would retain the simplicity of the technique and the character of leather and yet fetch better returns to the village tanner. While bag tanned leathers were used only for making sole *charas* leathers, etc., the improved methods have been found to be very suitable for the manufacture of football leather, cycle saddle leather, belting leather, leather goods, etc.

CLRI has devoted considerable attention to the technology of E I tanning. In contrast to the traditional process of long duration using minimum chemicals, rapid tanning techniques have been worked out. New and economical tanning processes for making E.I. tanned goat, sheep, cow calf and buff calf skins have been developed based on the use of chemically modified myrobalan infusion. E.I. tanning was also introduced in regions where it was not practised earlier.

The restrictions imposed on raw goat skins made the exporters to go in for wet blue chrome leather export and CLRI developed the necessary technology for the manufacture of wet blue skins and this item soon developed into a significant export item.

CLRI has been engaged in working out processes for preparation of finished leather throughout its period of functioning. This has assumed importance with the switch-over to finished leather. Know-how has been developed for a wide variety of finished leathers ranging from the routine items like uppers to sophisticated and specialty items like garment leathers, industrial leathers, sportsgoods leathers, upper leathers, softy nappa, aniline and semi-aniline, lining, oil seal leather, gas meter diaphragm leathers are representative examples of the leathers for which processes have been worked out by CLRI. The Institute is currently engaged in assessing possibilities of using imported raw materials for manufacture of finished leathers for export. Leathers for defence needs represent yet another facet of CLRI activities. High altitude leathers, air pilot's glove leathers are some of the items developed at CLRI for defence.

The inferior grade Indian raw materials have to be upgraded and this is mainly effected through novel methods of finishing to enhance the value. Tie and dye technique, screen printing technique, serofinish technique, novoprint technique are some of the techniques developed at CLRI.

CLRI has given great importance to prevention or minimising the deterioration in hides and skins through short-term curing technique using zinc chloride as the preservative. It has evolved an economical method for purification of salt used in curing which can be used for recuring with admixture of antiseptics like sodium pentachlorophanate, which will prevent pollution of soil and water by salt.

Cursal—a CLRI product—a mixture of sodium sulphate and magnesium sulphate has been shown to be an effective substitute for khari salt traditionally used for dry-salting. A dry-drum curing method has been standardised for preparation of both wet and dry salted hides.

Methods and processes have been evolved for better and rational utilisation of domestic raw materials. A successful method for graft polymerisation on hides and skins without destroying their native structure; technology for non-traditional use of buffalo hides in preparation of shrunken grain leathers, surgical instruments polishing leathers; processes for newer types of leathers like softy nappa, upper and lining, upholstery, sportsgoods leathers, oil seal leathers from conventional sources like cow hides have been given to the industry. Processes for utilisation of exotic species like frog, bandicoot, lizard, turtle, shark, dog skins and elephant hides have been demonstrated.

CLRI has worked out processes for reducing the consumption of wattle in the present practices and replacing wholly or partly wattle with indigenous tanning materials. A number of modified tanning extracts have been developed and some of these have been taken up by the industry for production. (Wattle is an acasia which supplies the bark used in tanning.)

All these processes have been demonstrated extensively in various parts of India even in remote villages with considerable benefit to the tanners. The Extension Area of CLRI has done commendable work in this respect through its Regional Extension Centres in Bombay, Calcutta, Jullundur, Kanpur and Rajkot, the southern region being served from Madras. It is gratifying to note that mere merchants of raw hides and skins have become finished leather manufacturers because of assistance by CLRI.

Leather-bound books (above) *continue to enchant bibliophiles even today in this age of ersatz leather.* Right: *A leather bag from Kashmir Valley bearing the lily motif.*

cent of set. They require to be set at high temperature- 120-160 C, also, longer durations are required even for such heat setting. Poromerics are also susceptible to surface damage from pressure and heat However, poromerics offer several advantages--(1) Absence of "cracking" (although a slight "greying" of the finish may occur if they are pulled too hard) (2) Because poromerics come in uniform sheets they offer a saving in cutting of some 15 to 20 per cent. Hides and skins on the other hand are irregularly shaped Also, because of their uniformity, they can also be piled one on top of the other and subjected to multiple cutting (The width varies and a single poromeric roll may yield 120 sq m.)

A Leather workshop. The regular shape of poromeric leather sheets reduces cutting losses.

A major disadvantage of poromerics results from their poor compressibility which makes lasting an exacting operation. Also the stitches may not "bed in" quite the same way as they do on leather. Beading or folding can be more difficult than it is in leather Heel covering is more difficult with poromerics than with leather.

Leather is much superior to the poromerics in flex endurance. The absence of rigid cementing substance and the fact that there are no weak points in leather contributes to two of its important properties --good resistance to flexing and retention of flexibility at low temperatures.

An important difference between leather and poromerics is that scuff-snag damage is much more difficult to repair with poromerics than with leather. In leather, the damage can be easily filled in with shoe polish. Not so with poromerics.

Poromerics have a fine break similar to that given by good quality leather A property important for good "eye appeal" after a period of wear is the shape of folds or flexing creases that occur across the vamp Good leather shows nicely rounded folds. The latest poromerics also have very good rounded folds.

Many poromerics show the so-called "Orange peel effect" when stretched, that is, they display an unevenness or pitting of the smooth surface. This is one of the serious shortcomings to be overcome.

Leather is known to transmit water vapour not only through fine pores between fibres but through the hydrophilic fibres themselves. The hydrophilic fibres in leather which run from grain to flesh ensure that the moisture is transported by absorption right through. Most poromerics by comparison have a hydrophobic fibrous structure with large voids in the substrate where moisture is transported by simple diffusion; the water vapour permeability of poromerics is found to be less than that of leathers. The water vapour absorption of poromerics is less than that of leathers. The rate of absorption and desorption of water vapour is also observed to be more with leather than with poromerics.

Poromerics are more elastic and "bedding in" as could occur in leather may not occur.

Continued on page 65

Iodine deficiency can range from thyroid enlargement to severe damage to the brain and the body of the growing child. In India, about 120 million people are exposed to severe environmental iodine deficiency

GOITRE

COME in please What is your problem?

Doctor, I have been noticing a swelling in front of my neck, which seems to be moving up and down when I swallow.

Did you notice the swelling by yourself or was it pointed out to you by others?

As a matter of fact my husband noticed it first, a few months ago He feels that he has been noticing some fullness in front of my neck ever since the delivery of our baby two years ago.

Let me palpate your neck You appear to have a goitre

What does that mean?

Goitre is a swelling of the thyroid gland which is one of the endocrine glands in the body located in front of the neck It has the shape of a butterfly with two lobes joined by a central thin strip The entire gland sits like a saddle in front of the wind pipe

Then breathing should be difficult

Very large goitres may do that They may produce hoarseness of voice by pressing upon the nerve supply to the vocal cords but in your case the size of the goitre is not very big You need not worry about any of those alarming symptoms

But the swelling of the gland means I must have a cancer Otherwise, why should it grow like that?

Fear and anxiety are the worst enemies of the patient Let me first dispel your worries in this respect Goitre is common in women around puberty and pregnancy In certain communities it is so common that it is considered a sign of beauty in women Very few goitres are due to cancer of the thyroid gland. Only when there is a localised, hard nodular swelling in some part of the gland, we consider the possibility of the cancer In your case, you have a diffuse, moderate-sized, uniform enlargement of the whole gland This type of swelling would be most unlikely to harbour cancer

What you say is most reassuring but why should I get this swelling and what should I

do about it now? I do not even know what the thyroid gland is normally supposed to do in my body

The thyroid is an important gland in the body It secretes thyroid hormones which control growth development and various metabolic functions of the body It picks up most of the iodide (a compound containing the element iodine)which is circulating in the blood stream This iodine is an important constituent of our diet

The thyroid gland has to rely on the external environment for the raw material (iodine) from which it makes the thyroid hormones Depending on the balance between the supply and demand for iodine, the gland varies in its functions and structure Consequently, it gets enlarged.

Like a factory where if you do not have the raw material, each unit would have to enlarge its work capability to meet the demands of the supply

Exactly The commonest cause of goitre is iodide deficiency There are certain parts of this country where goitre incidence is high. The foothills of the Himalayas, northern U P. and Bihar, Assam and some parts of Maharashtra and Gujarat have nearly 50 per cent of the population with goitres According to one estimate nearly 170 million persons in these areas are exposed to the risk of getting a goitre A recent study shows that nearly three per cent of the offspring in this area show evidence of thyroid hormone deficiency

What would these children suffer from?

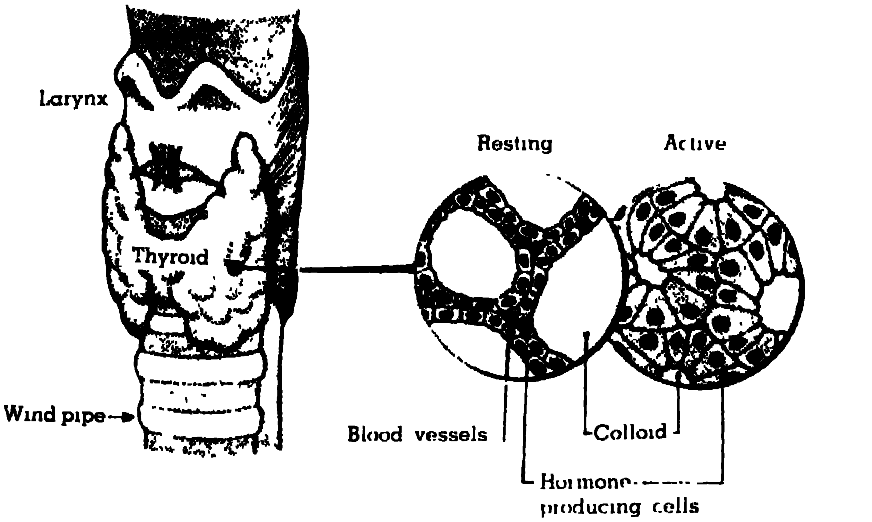
They would develop into what we call cretins They will be mentally retarded and their growth would be stunted The worst part of this tragedy is that it can be prevented. If the mother is given adequate supplements of iodine in her diet during pregnancy or if the child is given thyroid hormone supplements as medications soon after birth, there would not be any cretins in the endemic areas

So goitre is a national problem, even a nutritional problem to some extent But why can't the population get enough iodine in their diet?

Man obtains his necessary dietary intake from food and from drinking water The iodine content in food and water depends critically on its content in the soil. In the endemic zones, the soil and water are devoid of iodides Foods which are richest in iodine are the sea-foods, while smaller amounts of iodine are found in eggs, meat, milk and cereals Iodine content in vegetables, fruits and milk depends indirectly on the iodide content of the soil

As I am a vegetarian, I have few sources of iodine How much do I need to take daily?

About 100 to 150 micrograms of daily intake is recommended but at least 50 micrograms per day may be just sufficient to prevent the development of a goitre. A survey of some Bombay school children between the ages of 10 and 14 years showed, that nearly 36 per cent of the children from municipal schools had goitres. On the other hand, children coming from rich families and studying in private schools had a goitre



The thyroid and its structure

incidence of only six per cent. The nutrition taken by a large part of our population is not good enough to provide the necessary amounts of iodide.

If I want to take more iodine in my diet, how do I supplement my diet?

In Western countries, iodised salt is available, which can be used in place of common cooking salt. In India too there is an attempt to make some iodised salt available in endemic areas. In certain countries, where the iodised salt is not available, iodised oil injections have been found to be highly effective. However, in your case, I don't suspect iodine deficiency.

There may be many other reasons for goitres, such as certain genetic defects interfering with the synthesis of thyroid hormones, the presence of some unidentified factor in the diet producing similar interference, and a type of disease known as an auto-immune disorder in which the body's own defence mechanism turns against itself.

What will you advise me to do now?

I shall like to carry out some investigations before I decide about your treatment. I shall like to take a thyroid scan.

What is that?

You will be given a small, safe amount of a radioactive substance which is either iodine or a chemical behaving like iodine. This substance goes to the thyroid gland and the mapping of its distribution in the gland by an electronic instrument produces an image of the gland. This image shows the functional integrity of the different regions of the thyroid gland. If there is any focal functional defect in your goitre it would be visualised in this image.

Suppose you find a focal defect in one part of the thyroid, what would you do?

In your case I don't expect any such abnormality as on palpation I don't feel any focal nodularity or difference in the consistency in your gland. If there is a focal defect, I would have to consider the possibility of a thyroid cancer.

If anybody has to have cancer, I would say that it would be better to have thyroid cancer, which in most cases is totally curable. Another thing that I would like to find out about your goitre is the way your thyroid gland functions now.

Why should it be abnormal?

Your thyroid gland is enlarged, which means that it is trying to cope with extra work. If there is ineffective hormone production, it would mean that, although enlarged in size, it does not produce enough hormones for your needs. You would then, have symptoms of thyroid deficiency. The other possibility is that the gland is really overworking and overproducing the hormones. This would result in the symptoms of thyroid hormone excess or what we call, a toxic goitre, a sort of being intoxicated with an excess of your own thyroid hormones.

Do I have a deficiency or an excess?

First tell me a few things. Have there been any changes in your weight, appetite and bowel habits?

No. None at all. I don't feel tired, lethargic or slowed down either.

You don't seem to have any symptoms of thyroid hormone deficiency.

Then, I must be suffering from an excess of thyroid hormones.

No. I don't think so. In the hyperthyroid state, you would lose weight, be nervous and anxious, would get palpitations and would be losing weight in spite of a ravenous appetite.

Some patients with overactive toxic goitre develop bulging or protruding eyeballs. They also get fine tremors in their hands.

Since there are no symptoms of thyroid hormone excess or recession, I assume that I have normal thyroid function.

Yes, I think so. We can confirm this by a simple test which involves taking your blood sample and estimating the levels of thyroid hormones in your blood.

Is that easy? Will it be very expensive?

The levels of thyroid hormones in the blood is measured by a method called radioimmunoassay. By the same method, we can also measure the levels of the pituitary hormones which exercise a controlling influence on the thyroid gland.

Would that expose me to radioactivity?

In radioimmunoassays, a radioactive substance is mixed with your blood in a test tube, but there is no administration of a radioactive substance to the patient.

There is nothing to be afraid of. There are many thyroid function tests where small amounts of radioiodine are used but in trace amounts. Most of the radioisotopes do not have deleterious effects. In your case there is no need for any of these tests.

Then what treatment should I take?

You seem to have what we call a simple non-toxic goitre with normal thyroid function. If it is cosmetically not very critical, there is no need to remove surgically small and moderate-sized goitres.

But what if the goitre increases?

I shall call you for an examination every three months. If I find that your goitre is increasing in size, you will have to take some thyroid hormone tablets.

Then I'll get thyroid excess!

No. Not with the proper dose. Synthetic thyroid hormones are also available commercially. If you take your normal requirements of these hormones by way of synthetic thyroid pills, your thyroid would not have to work excessively. When it gets something ready made, it does not have to work hard to produce it and so starts shrinking gradually.

Doctor, please tell me what would you have done if I had thyroid overactivity.

The line of treatment would then have been completely different. I could have advised removal of your thyroid by surgery or I could have ablated it by giving a sufficiently high dose of radioiodine. Both these methods are irreversible and the offending thyroid is partly destroyed to curb its undesirable overactivity. In many cases, I just might use anti-thyroid drugs to control the activity of the thyroid gland.

And if I have thyroid deficiency, you would have recommended oral doses of thyroid hormones.

Exactly.

R. D. Ganatra

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Nickel

an essential micronutrient

Nickel toxicity induces chlorosis resembling that of iron deficiency. Picture shows iron deficiency in cotton and safflower

PLANTS require about 15 to 20 mineral elements for normal growth and for completion of their life cycles. With the identification of a mere ten elements by J Sachs in 1860, the list of elements essential for plants has been ever increasing. Today, about 20 of these are experimentally proved to be required by a number of crop plants. Further it was Sachs who had routinely included 0.5 gm of sodium chloride (NaCl) in his nutrient medium, not knowing then that sodium and chlorine were needed by plants.

The discoveries of additional elements as growth factors are largely due to the use of well-refined techniques including the plasma-emission spectrography for analysis of salts. These techniques have helped to identify many more elements like aluminium, bromine, cobalt, chromium, iodine, silicon, selenium and titanium. Interestingly, the influence of titanium on chlorophyll synthesis was recorded as early as 1913 and it remained in oblivion for many years. Most of these elements function as co-factors in enzyme reactions, and are generally required in amounts as low as 0.001 per cent or parts per billion, higher amounts proving to be toxic.

Nickel is an element considered to be poisonous to plants even at 10 parts per million (ppm), higher concentrations of 150 ppm stopped the growth of tomato plants. High amounts of nickel are also known to be toxic to oats, lettuce and cabbage. This element is closely related to cobalt, both in its chemical and physiological properties. It readily forms chelates and thus can effectively replace other heavy metals from the physiologically important centres. Furthermore, nickel toxicity gives rise to symptoms of chlorosis, where there is blanching of the green parts of a plant, especially for want of iron.

The beneficial effects of nickel in low concentrations were indicated as early as in 1916, when W A Roach and C Barclay obtained significant yield increase following nickel sprays to crops. Now, the experiments described by David Eskew and his colleagues (*Science* **222**, 621) have shown that nickel at 1 ppb increased the utilisation of nitrogen by a leguminous plant, soya bean (*Glycine max*). Lack of this element leads to the development of foliar lesions. These have been analysed and found to contain high amounts of urea. The activity of the urease enzyme which breaks down urea is also enhanced by nickel at 10 ppb. However, an accumulation of nickel to about 6.37 nanograms per gm of seed following nickel treatment as shown in the present research, raises the question whether its accumulation in biological systems through the food chain could create health hazards. Selenium, titanium and cadmium toxicity to living organisms has been well recorded in the last few years.

In a recent review on the biological significance of nickel it is reported that the ureides (allantoin and allantoic acid) are the major forms of nitrogen translocated from nodulated roots to the tops of soyabean plant. Nickle is required, therefore, for leguminous plants which transport large amounts of nitrogen from roots to tops via ureide compounds. In this connection, knowledge of the mechanisms of absorption and sites of accumulation of nickel in different plant parts would be useful in the regulation of supply of nickel to an optimum level to plants. Foliar supply of quantities less than 1 ppb may prove to be adequate enough for enhancing urease activity and nitrogen utilisation in leguminous crop plants.

S. Kannan

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Geomagnetic reversals and galactic motions of the solar system

SCIENTISTS of the National Geophysical Research Institute, Hyderabad, Drs Negi and Tiwari, have brought out an interesting correlation between the various periodicities of galactic motion of the solar system and the reversal periodicities of the geomagnetic field (*Geophysical Research Letters*, **Vol. 10**, 713). The Earth's magnetic field varies in geometry and strength on all time scales from 10 to 10^9 years. There may be variations on time scales shorter than 10 years, but these are completely screened off by the lowermost part of the mantle from reaching the surface of the Earth. Negi and Tiwari have investigated the long-term variations covering a period of about 30 to 285 million years.

The study uses the world-wide

paleomagnetic data of McElhinny covering the period extending back to 570 million years. Though this data-set has been analysed earlier, present work is significant as the technique of identifying the reversal periodicities is more realistic. Earlier studies had used either the method of 'fast fourier transform' or the 'maximum entropy' method. In both, the approximating function is a sinusoid It is known that the actual reversal time of the Earth's magnetic field is much shorter (~ a few thousand years) than the time of reversals

The authors rightly argue that this class of changes are more abrupt like the telegraph signals and they should be expanded in terms of Walsh functions The Walsh Spectra exhibited peaks centred around 285, 114, 64, 47 and 34 million years. To check the stationary behaviour of the reversal sequence, they carried similar spectral analysis by dividing the entire series into two parts spanning the period (0 to 285 and 285 to 570 million years). The results confirmed the statistical significance of the identified peaks

Earlier in 1969, Crain and his coworkers have correlated the long time reversal periodicities with the period of revolution of Milky way galaxy. The maximum spectral power found for 285 million years coincides with the period of 280 million years of complete revolution of the solar system around the Milky way galactic centre. The galactocentric radial motion of the Sun has a 120 million year periodicity and this may correspond to the 114 million year peaks in the Walsh spectrum Solar oscillation in and outside the orbital plane has a period of about 40 million years corresponding to the 47 million year periodicity in the reverse process

Through these associations a remarkable correlation between the geomagnetic reversals and the galactic motion of the solar system has been brought out. Negi and Tiwari mention that physical mechanism of such association is not possible at this stage. Fluctuations of the geodynamo in a period of 10^7 to 10^8 years have been predicted, due to the variability of mantle convection. It would be an interesting and challenging exercise to find now the causal link If we believe that the primary driving mechanism of the geodynamo is the gravitational energy, one possibility then would be to look for an association through the changes in gravitational energy An unification of geophysics and astrophysics may thus follow in a unique way.

A remarkable correlation between the geomagnetic reversals and the galactic motion of the solar system has been established from existing data

Bhisham Prasad Singh

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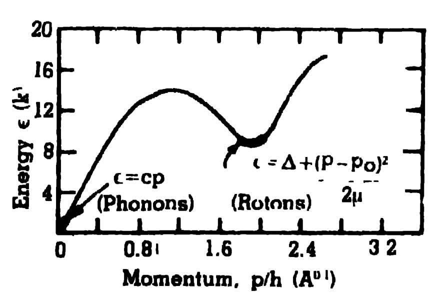
Phonokinetic effect in liquid helium

RECENTLY, an acoustic analogue of photoelectric effect has been reported by M. J. Baird and his colleagues (*Nature* **304** 1983) They have shown that a phonon or a sound quantum in liquid helium (^{4}He) with energy greater than the binding energy of a helium atom, propagates to the free surface where it is either reflected or gives all its energy to an atom on the surface This energy is used by the atom, partly to overcome the binding forces and the rest is carried away as its kinetic energy

In liquid helium at 2°K, the thermal de Broglie wavelength of the atoms is comparable with the interatomic distance, implying that it is a quantum liquid. It remains so down to the absolute zero of temperature. In such cases, one should not consider the motion and states of separate atoms, but quantum states of the whole system of interacting atoms. According to quantum mechanics, a system of particles with arbitrary interactions can be looked upon as a set of distinct elementary excitations if the excitation energy is low The function which relates the energy of these excitations to their momentum is called the energy spectrum or the dispersion curve The dispersion curve for ^{4}He is shown in the figure. At low values of momenta, we see long wave length density excitations which are obviously the longitudinal sound waves. Phonons are the corresponding elementary excitations. The elementary excitations whose energies lie near the minimum of the dispersion curve are called rotons and do not have to be considered here.



Dispersion curve of liquid helium

According to the authors these two factors helped them in demonstrating this experiment. Firstly, if liquid helium is cooled to a temperature below 0.1°K, the number of thermally excited phonons is so small that scattering from them is negligible. A phonon emitted into this cold liquid propagates until it either spontaneously decays or reaches an interface Its mean free path (λ) is limited by spontaneous decay and is a strong function of the energy of the phonon. However, at energies higher than 9.5°K, the dispersion curve is convex upwards and, therefore, the normal decay involving conservation of energy and momentum is no longer possible Hence, there is a range of phonons with energy between 9.5°K and 14°K which have enough energy to desorb a surface atom and have a long mean free path in the liquid

Secondly, to show that it involves a single phonon excitation and a single atom in a one-to-one process requires the measurement of the energy of the incident phonon beam and the kinetic energy of the liberated atom To do this, they have used the dependence of group velocities on the energy of the phonon and atom which are known from neutron scattering experiments in liquid helium. In the experiment, a pulse of phonons is injected into the liquid by the heater and is collimated into a beam directed at the liquid vacuum interface. Atoms liberated at the surface travel through the vacuum to a bolometer which detects them The time of flight of these liberated atoms can be calculated from the dispersion curve

The authors have obtained good agreement between the theory and the experiment The results have also been checked by adding ^{3}He atoms to the pure ^{4}He, from which they can infer the binding energy for ^{3}He atom This agrees well with the earlier findings Thus, the authors have successfully established a phonokinetic analogue of the photoelectric effect.

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Spine of The Electronics Industry

N. S. K. Prasad

HUMAN ingenuity in utilising materials available in nature to synthesise new ones with tailored properties for specific purposes has pushed civilisation from stone age to 'silicon age'. Silicon (silex, silicis mean flint in latin) follows oxygen as the most abundant element in the earth's crust, being present to an extent of 27.8 per cent. Due to its strong affinity for oxygen, silicon readily forms silicon dioxide or silica. Hence it occurs in nature mostly as silica in sand and quartz, and as a variety of inorganic silicates.

...ous silica has low thermal expansion

Silica is also a major constituent of gems such as amethyst, carnelian, jasper and onyx On combining with water it imparts iridescence to opal. It is also found in the feathers of birds, in the ashes of burnt oats, barley, rice hulls, and tobacco Even egg shells and skeletons of marine animals are composed of it

Though flints were the first implements used by mankind, silicates in them were processed much later for making glass and porcelain. With the advance of civilisation, naturally occurring siliceous material in the form of sand, clays, asbestos, mica and vermiculite have found extensive applications in building construction, and also in petroleum, ceramic, chemical and other industries. Quartz occurring in nature has been used for long for stabilising the frequency of radio transmitters and receivers, and more recently of electronic watches and clocks.

Synthetic world of silicon

Silicon which is a close neighbour of carbon emulates that element in many respects It forms the same type of crystal as diamond though the inter atomic forces in silicon are much weaker. Like carbon, silicon too forms a diversity of compounds, but in the realm of inert substances. Silicon, its various alloys, cermets or ceramic metals, silicates (soluble and insoluble), silicon carbide, silicon nitride, silicon monoxide and a host of orgáno-silicon compounds have all appeared throwing open new avenues for industrial development.

The wide world of silicon started unfolding only in the beginning of the century Silicon, when alloyed with iron, as silicon steel is extensively used in electric motors and transformers. As a constituent of silicon-aluminium alloys, it has a special use in car engines When fused silicon is bonded with finely divided ceramic particles, we have cermets which are extremely resistant to oxidation, possess higher thermal conductivities and thermal shock resistance than the ceramics. They are being used in high temperature bearings and cutting tools.

The development of silicon carbide fibres has added a new dimension to the area of composites suitable for high temperature applications. Also, silicon carbide and silicon nitride have found numerous uses based on their outstanding properties such as, hardness, chemical inertness and high temperature stability.

Cermets' high thermal shock resistance!

Francis D'sa

Silica and Silicates

Synthetic, vitreous and amorphous silica are three different forms of the same substance, silicon dioxide. Synthetic silica or artificial quartz, has already replaced natural quartz in many applications. Vitreous silica can be either translucent or transparent. In both these forms it is mostly used in scientific and technical equipment. Chemical glassware of vitreous silica are required when high temperature reactions or UV photochemical reactions and processes are being studied. Vitreous silica is also used as thermocouple sheaths and for protecting the elements of infrared heaters. The properties exploited in these applications are, the low thermal expansion, good refractory qualities, high thermal resistance and ultraviolet transparency and the excellent chemical inertness of this form of silica. Its good UV transparency is the reason why lenses, prisms, solar cell windows, mirror blanks for large astronomical telescopes and envelopes for mercury lamps are all made with it. Amorphous silica too finds varied uses, depending on its form and purity. As a pigment and filler in paintings and coatings, as an anti-sticking, anti-static, and anti-soiling agent, as a reinforcing material in rubber, to improve ink retention of paper, as a catalyst... the list seems never ending.

All silicates are built of a fundamental structural unit (Fig. 1). The soluble silicates find their largest application as industrial and household detergents. While the strongly alkaline grades are used for bottlewashing in dairy, brewery, and soft drink industries, the less stronger ones are used in laundering, in metal degreasing, to remove oil and grease from floors as well as work surfaces. As adhesives, they are used in the manufacture of corrugated cardboard packaging, heat resistant paints, acid resistant cement and as binders in the manufacture of welding rods.

The synthetic insoluble silicates are useful for synthesising zeolites, which serve as ion exchangers in water treatment and for purifying sugar syrups

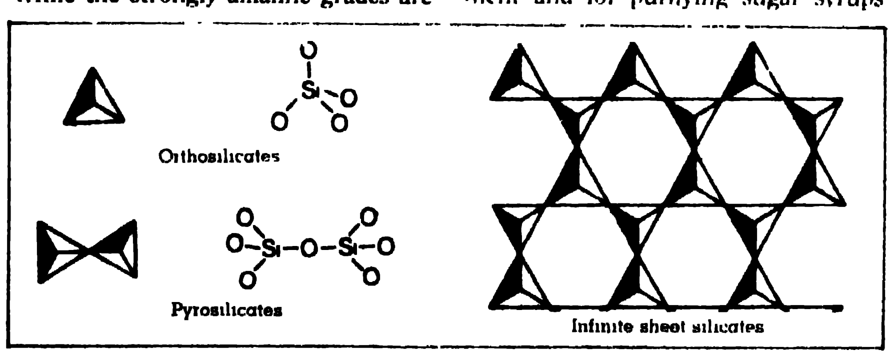


Fig.1 The basic unit S_iO_4 tetrahedron is arranged in various ways to form silicates.

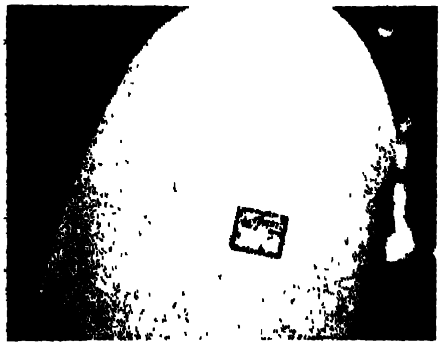


***Fig.2** A silicon chip on a human finger. A remote controlled toy car will have two such chips.*

and juices. These are also used as cracking catalysts in the petroleum industry and as adsorbents in decolourising food products and mineral oils.

Organo-silicon compounds in the form of organic silicates and silicones have phenomenally increased the role of silicon in the industry as well as in our daily life in the last fifty years. Just to give some examples, methyl silicones find wide ranging applications in chemical, electrical, metallurgical, food, paper, textile, leather, and several other industries as emulsions, defoamers, dielectric fluids etc. Methyl phenyl silicones are used as diffusion pump fluids in high vacuum technology. Aryl silicates are used as heat transfer fluids in chemical processing industries.

Despite such a broad and diverse technological base, silicon remained in obscurity, until the element by itself revolutionised modern electronics.

Silicon rules supreme

The earliest use of silicon can be traced to the days of cat's whisker receivers, when a silicon crystal with point contacts (cat's whiskers) was used in the detection of wireless signals. The silicon transistor was invented fortyfour years later, in 1950 The silicon chip which is mainly responsible for revolutionising the device technology, and for ushering in of the silicon age, appeared in 1958.

Why does silicon rule supreme among the semiconducting materials? The importance of silicon as the primary material for the electronics indus-

This silicon gas chromatograph, micromachined from a silicon wafer can sit on a palm.

try stems from, the abundance of its raw material in nature, the high temperature stability of its devices, the possibility of covering it with a stable oxide layer which can be removed by simple chemical etching processes and its adaptability to miniaturisation and microminiaturisation.

In the last two and a half decades silicon in the form of devices has been playing a dominant role in fields as diverse as transportation, medicine, engineering communication, domestic appliances and also entertainment. The importance of silicon as the raw material for electronics industry has resulted in a phenomenal rise in its production (Fig. 3).

However, there are other potential

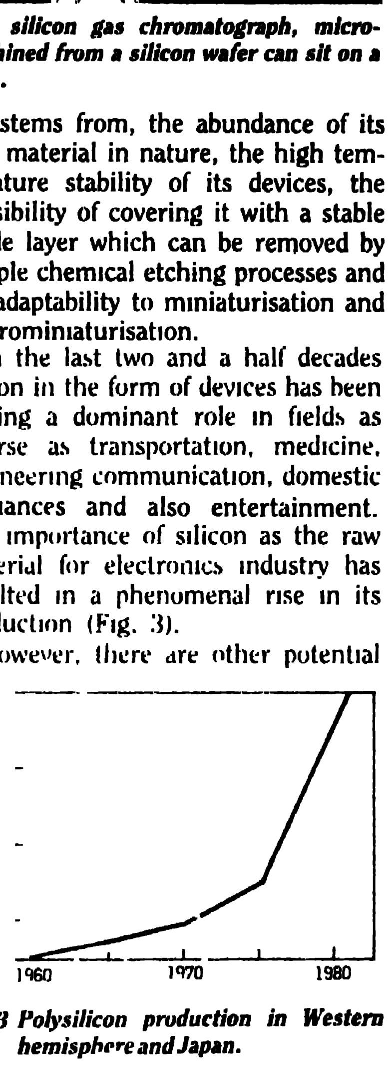


***Fig.3** Polysilicon production in Western hemisphere and Japan.*

uses of silicon which are much less publicised. The techniques that have made miniaturised electronic devices possible are also being employed to make compact mechanical devices. The mechanical properties of silicon single crystal such as its hardness, ability to cleave, resistance to stress have proved micro machining a reality. A gas chromatograph which is so small that it can easily fit into a palm is shown in Fig. 2.

Silicon was first isolated in 1817 by the German chemist Berzelius. He reduced potassium silicofluoride with potassium metal. In 1854, Sainte Claire Deville obtained a silicon crystal in a higher degree of purity by crystallising it from a solution, in molten aluminium. Since then its extraction and purification has become considerably important with its growing use for alloying, in semiconductor devices, for the manufacture of silicones and for cermets.

Ultra-pure silicon

Commercially, silicon of 96-98 per cent purity is obtained by reducing silica with coke in an electric furnace, at a temperature of 1770 degrees Kelvin. This is aptly termed 'Metallurgic Grade' silicon as its major application is in the steel and aluminium industries. The total world production of silicon is close to two million tons per year. Out of this, metallurgical grade amounts to three quarters of a million tons. With the increasing demand for solar cells the annual requirement of metallurgical grade silicon will be substantially higher by the turn of the century. At present the steel and aluminium industries consume 94.5 per cent, of this grade. Of the remaining, 5 per cent is used up by the silicones industry leaving a meagre 0.5 per cent to satisfy the needs of the semiconductor industry. The cost of metallurgical grade silicon in the global market is US \$1 to \$2 per kg.

However, the silicon used in the semiconductor industry needs to be extremely pure. Even minute quantities of certain impurities can affect drastically its electrical properties. The limits of tolerability vary depending on the impurity. For boron and phosphorus the limit is one part per billion. This level of contamination is comparable with a single small stone present in 10 tons of rice. The limit for carbon and oxygen are 0.5 and 1 to 10 parts per million respectively.

Estimates for the installed produc-

"The demand growth is continuing and is expected to continue for decades to come'

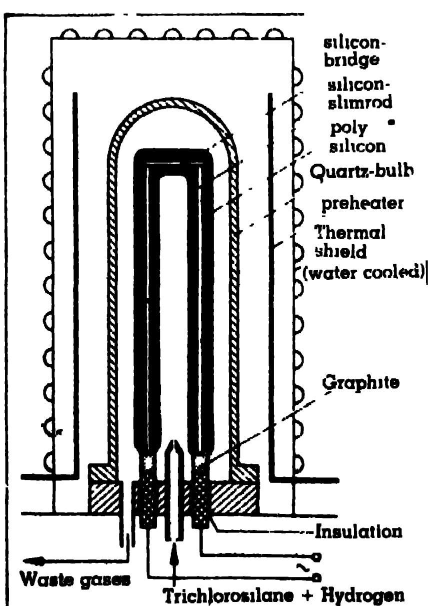
tion capacities for semiconductor grade silicon are in the range 4000-5000 metric tons per year excluding the East European countries and China. The market price of the material which was more than 100 US dollars per kg in 1962 at current dollar value has come down to almost half the value in 1982-83, depending on the tonnage. From 1976 to 1979 the world annual usage of silicon in semiconductor devices more than doubled from US $6,000 to US $13,000 million. The demand growth is continuing and is expected to continue for decades to come.

Semiconductor grade silicon cannot be obtained from metallurgical grade by physical methods alone. Chemical purification therefore, becomes a necessity. The technology for obtaining ultra-pure silicon has evolved over many decades and many intricate aspects of it are closely guarded secrets.

Chemical processing of metallurgical grade silicon started with purification by leaching. of the powdered material with various acids. The silicon powder thus obtained was 99.99 per cent pure and was essentially used for microwave diodes.

The present method however consists in synthesising a suitable intermediate such as silicon tetrachloride, trichlorosilane, or monosilane to begin with. The intermediate is then purified to the desired level and the pure intermediate is then converted to elemental silicon.

The purity levels desired in the silicon product has necessitated evolutionary changes in the design and construction of polysilicon deposition reactors. It is also the case with the choice of the substrate material used for silicon deposition from its intermediate. The ultimate success in this effort was due to the development of silicon slim rods to serve as deposition substrates. The substrate could now be heated electrically, keeping the silicon product out of contact with the reactor vessel material, thus minimising contamination.



Siemens process

Silicon technology developed in the initial stages parallel to that of germanium, the pioneer material of semiconductor technology. But silicon dioxide or silica cannot be directly reduced, unlike germanium dioxide. When metallic reducing agents such as zinc are used for reducing silicon tetrachloride there are limitations on the ultimate purity of the product obtained. If instead hydrogen were used, the yields are poor.

***Fig.4** The deposition reactor where polysilicon is produced by the decomposition of trichlorosilane.*

***Fig.5** Polysilicon rod from a deposition reactor*

Du Pont, USA were the first to try out a large scale preparation of high purity silicon by zinc reduction process. They undertook to produce a thousand pounds of pure silicon for Bell telephone laboratories in 1952. Since the purity of the product was only 99.99 percent, they switched over to the monosilane route. In this process silicon tetrachloride gets converted to monosilane (S_iH_4), on reacting with Lithium Aluminum Hydride. This reaction needs to be carried out in an ether medium. Unfortunately, an explosion at the Du Pont factory brought this effort to an end. An accidental fire in the ether medium, aggravated by the explosive nature of monosilane was the cause of the disaster.

Then the entire course of silicon technology changed. At present ninety-nine percent of the global production of semiconductor grade silicon is based on what is called Siemens Process. This process was developed by Siemens. West Germany during 1953-56.

The process uses as raw mateiral the readily available trichlorosilane which is a major silicon intermediate for the silicone industry. The trichlorosilane is synthesised by reacting metallurigical grade silicon at 250-300°C with anhydrous hydrogen chloride gas, condensed from vapour phase to liquid phase, purified to semiconductor grade by distillation and then decomposed to elemental silicon by reduction with hydrogen at 1000-1100°C on silicon filaments heated electrically in a Siemens type rod reactor (Fig. 4). The polysilicon deposited in U-form in such a reactor is shown in Fig. 5. The highest purity silicon obtained this way contains 0.03 and 0.2 parts per billion of boron and phosphorus respectively. The favourable balancing factors in the manufacture, purification, handling and chemical reduction of trichlorosilane are responsible for the wide use of the Siemens process in spite of its high energy consumption relatively low efficiency and large quantities of undesirable silicon tetrachloride byproduct.

Semiconductor devices depend not

Semiconductor grade will continue to support solar cell technology for some more years to come

only on the purity but also on the perfection of silicon crystals. Silicon success story owes much to the techniques of growing large and perfect single crystals. Czochralski method and float zone method are two such techniques often used for growing crystals of diameter 15 to 10 cms respectively. Techniques to grow silicon webs and ribbons to reduce cost in solar cells fabrication are also being developed.

Solar cells

The energy crisis of the 1970s triggered by the soaring oil prices forced a fresh thinking on alternative energy sources. The direct conversion of solar energy to electrical energy turned out to be a major alternative. Silicon solar cell which was already developed essentially for space applications was the natural choice.

The projections made for the global energy needs by the turn of the century is almost 20 thousand billion watts. Even with a modest aim of generating 5 per cent of this energy with solar cells, we need about 2 million tons per year of the basic material silicon. This is so, considering the average solar silicon cell to be 10 per cent efficient.

The break-even cost of polysilicon for effective use in solar cells is estimated to be 14 US dollars per Kg at 1980 dollar value. This cannot be met by the Siemens process However, the possibility of developing an intermediate grade silicon, essentially for solar cell has also been considered. This grade will lie between metallurgical and semiconductor grades as regards to its purity. Apart from the cost and efficiency goals, it is important that the total energy involved in the production process be less and the energy pay-back time of the cell satisfactory. The pay-back time is defined as the length of time a solar cell must operate in order to generate a quantity of electrical energy equivalent to the energy expended in its making.

Amorphous silicon

The growth of silicon device technology is marked by miniaturisation and microminiaturisation, reducing thereby active area of silicon used by a single component. Solar photovoltaic industry on the other hand needs larger and larger active areas. Amorphous silicon, used in the solar cell is a material, made of silicon alloyed with impurities like hydrogen and fluorine (Fig. 6). It has no definite crystal structure as its atoms are randomly arranged. An advantage of amorphous silicon when used in solar cells is this: thinner layers of it are sufficient for effective photon absorption as compared to the much thicker layers needed, of crystalline silicon. This in effect would reduce silicon consumption from 20 Kg/kW by a factor of 200 to 300.

Fig.6 Silicon atoms (black) are arranged in an irregular fashion in amorphous silicon. Hydrogen atoms (white) are attached to dangling bonds.

As the properties of amorphous silicon are not fully understood it is not yet possible to exploit it for power generation on a large scale. However, solar cells based on this have already made their way into calculators and other electronic gadgets used indoors. The deterioration of amorphous silicon solar cells in direct sunlight is a factor which has so far restricted its use for indoor purposes only. A major application foreseen for amorphous silicon is in the drums of photocopiers, where currently selenium is being used. Other possible uses are in optical sensors, image sensors and as image orthicon elements. The theoretical (maximum possible from calculations) efficiency of amorphous silicon solar cell is estimated to be 24 per cent. Practical efficiencies attained are 6 to 9.5 per cent, depending on the cell size.

In the coming years, amorphous silicon may bring about revolutionary changes in solar cell technology in a manner analogous to microelectronics in the field of modern electronics.

Silicon scene in India

Electronics infrastructure in India has been growing without an adequate base in the vitally important material, silicon. Commercially, though Mettur Chemicals have embarked on the commercial production of semiconductor grade polysilicon, material of the desired quality is yet to be marketed. As regards single crystal products, in-house facilities for a limited production exist at BEL, Bangalore; ECIL, Hyderabad; BHEL, Bangalore and CEL, Sahibabad. Siltronics, Bangalore and Super Semiconductors Ltd, Calcutta have recently set up manufacturing facilities for single crystal products, on a commercial basis. With the setting up of the Semiconductor Complex Ltd, Chandigarh to produce 5 million semiconductor circuits both LSI and VLSI, and the approval of the National Solar Photovoltaic Demonstration (NASPED) programme by the Government with an outlay of Rs. 12 crores over 5 years, a new picture has emerged. The NASPED to be implemented by Central Electronics Ltd (CEL) aims at producing 1 megawatt equivalent of solar photovoltaic cells per year by 1985–86. The solar cell requirement for the nation's satellite programme planned by the Department of Space are also expected to rise.

Against this background, a proposal for the setting up of a National Silicon Facility (NSF) as a centre to be run by the Department of Electronics was initiated by the Government in November 1981. The task force set up for the purpose has submitted its recommendations to the government for the setting up of a polysilicon production facility to meet the country's silicon needs till 1990.

Dr. Prasad is Head, Silicon & Silicon Products Section, Uranium Extraction Division, BARC

TSS—THE TAMPON SYNDROME

Tampons are small, handy and highly absorbent, but beware! They can lead to problems.

TINA had finally done it! She had made the swimming team! She rushed home, ran to the fridge and gulped down a glass of orange juice to soothe her aching throat. Suddenly a shiver shook her healthy frame

By nightfall, Tina's ecstasy had turned to pure misery. Fever clouded her senses while diarrhoea and vomiting weakened her still further. By 11 p.m. she was rushed to hospital, straight to the intensive care section. Her condition was bad -her blood pressure dropped, her body broke out into an ugly rash It was totally inexplicable What was the matter with this normal, healthy teenager? Soon she became disoriented, irritable and screamed in agony at the slightest touch.

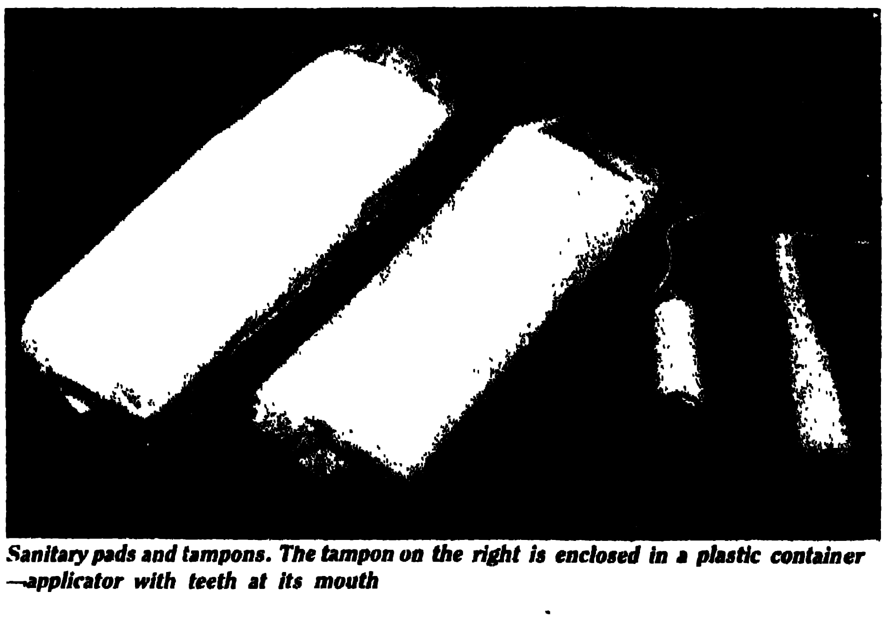
The nurse, while preparing her for the emergency room, found a tampon in place and removed it. Tina slowly began to recover. Within four days she was out of the intensive care section, and within a week she was well enough to go home. Two weeks later, the skin from the palms of her hands, soles of her feet, and even her face, began to peel off in layers and soon she was back to normal Tina was a victim of 'toxic shock syndrome'

Toxic shock syndrome or TSS, as the above disease-symptoms are usually known, is almost exclusively seen in women during their menstrual period The vast majority of the cases occur in women, who use tampons Tampons are especially designed to absorb menstrual blood flow They differ from sanitary pads or napkins in that they can be inserted internally into the vagina Since tampons are a relatively recent introduction into the market, the question naturally arises Is toxic shock syndrome a recent phenomenon"?

It is difficult to answer Menstruation is as old as women, in fact, it also occurs in other mammals such as dogs and rats Through the ages women have tried to devise ways and means of dealing with the 'curse', which restricted their movements and in certain cultures even isolated them from the mainstream of life In prehistoric times, women used bark, leaves and fibres to deal with menstrual flow Perhaps these practices are still prevalent among certain tribals in various parts of the world In some traditional societies women used strips of linen and other home-made devices of cotton and fabrics, to collect menstrual flow.

The desire to lead a normal, active life, even while menstruating, probably prompted the development of the tampon and other internal insertions to collect blood flow. Rural women, in certain parts of India, have been using pieces of linen inserted internally You may ask, about the incidence of TSS in these women Though TSS is unheard of among them, we are aware of the high rate of mortality and the high incidence of different urinogenital diseases among these women. Their socio-economic conditions, combined with the near unavailability of medical help and the illiteracy prevailing in these areas makes the detection of this disease difficult, if not near impossible.

Tampons were first marketed in the 1930's Dr Earle Haas developed the first commercially marketed tampon, a plug of lint, to save his wife the discomfort of menstrual pads Since those early days, tampons have not remained simple, innocuous wads of compressed cotton. They have undergone several changes to improve their absorbency and acceptability. The newer tampons are made from superabsorbent concoctions of chemicals and natural and artificial materials The most sophisticated of the latest tampons in the West, consist of a sort of a tea-bag filled with squares of polyester sponge and superabsorbent cellulosic particles Recent laboratory experiments have revealed that polyurethane, an important ingredient for



Sanitary pads and tampons. The tampon on the right is enclosed in a plastic container—applicator with teeth at its mouth

super-absorbency used in these tampons, has toxic effects on the vaginas of rabbits.

The association of TSS with the newer types of tampons is explained in various ways: Tampons create an ideal environment for bacteria to proliferate in a warm and enclosed vagina. The super-absorbent tampons are left in the vagina for longer periods than other types and so become ideal breeding grounds for bacteria. Another opinion is that, since they block the vagina, toxic blood seeps back into the fallopian tubes, peritoneum and then into the general blood stream.

What causes toxicity?

Perhaps the carboxymethyl cellulose, an absorbing agent used in these tampons acts as a breeding agent for the toxic strains of *Staphylococcus*. *Staphylococcus aureus* is a common disease-causing bacterium, that in addition to TSS, causes food poisoning, festering wounds, boils, abscesses and inflammation of bone tissue and bone marrow. Also artificial fibres and deodorant chemicals used in tampons may trigger allergic reactions in the users. The plastic teeth of applicators used to push tampons into the vagina, may scrape the vagina possibly giving rise to open wounds which are susceptible to infection. Toxicity may also be due to the super-absorbent materials used in tampons. These materials may cause dryness of the vagina, thus making it more vulnerable to infection and ulceration.

According to Desmund Bluett, a British gynaecologist, the use of tight underwear, made of synthetic fibres, seals off oxygen from the vagina. This creates conditions in which the potentially harmful bacteria develop and TSS results. Other researchers are of the opinion that the use of oral contraceptives, like the pill, results in decreased vaginal secretions. This makes vaginal cleansing less efficient and consequently the vagina becomes a breeding ground for various types of bacteria, some of which may be harmful. Intrauterine contraceptive devices like the loop and the copper 'T' may also cause internal infections which flare up when tampons are used. Bad quality tampons too, may increase the users' susceptibility to TSS. Though toxic shock syndrome is associated with tampons, tampons themselves do not cause TSS.

TSS—a disease

TSS has been recognised only recently as a disease. It was first described in 1978, by the Colorado paediatrician James Todd. Since then 70 American women have died allegedly due to TSS, about 800 are reported to have suffered serious side effects. Few cases have been reported outside the US though about a dozen cases have been reported in Britain. So far no cases of TSS have been recorded in India.

There could be many reasons for this. Though pelvic inflammatory disease and disorders of the urogenital tract are quite common in our country, their association with the use of tampons has not been looked for. Secondly the limitations and inadequacy of our health care system makes it difficult, if not impossible for doctors to locate and tend to these cases let alone document them. Thirdly, super-absorbent varieties of tampons are not widely available in India and consequently the incidence of TSS may be low.

Symptoms of TSS

The symptoms of TSS are similar to those seen in other septic infections caused by the bacteria staphylococci. They include the onset of fever, vomiting, diarrhoea, rash formation, sore throat, conjunctivitis, headache, irritability and muscle pains. These symptoms are accompanied by abdominal tenderness and discomfort. A few weeks after normalcy returns, the skin of the palms, face and soles may peel away in layers (desquamation). In severe cases, low blood pressure (hypotension), complications of the respiratory system and kidney failure have been reported. The Center for Disease Control, Atlanta, USA, reported 52 cases of TSS in 1980. In 51 of these cases, TSS occurred during menses. Only one woman, already had a severe septic infection when TSS occurred. Two per cent of the reported cases occurred among women who had recently given birth or who had both abscesses and septic wounds due to staphylococcal infection. TSS is also seen in women with a high incidence of *S. aureus* in their vaginas.

The pathophysiologic basis for TSS is not clear yet. Though TSS is caused by the bacterium *Staphylococcus aureus*, the organism itself does not appear in the blood of TSS patients, only a toxin or poison secreted by the bacterium appears in the blood of patients suffering from TSS. It has been proposed that this toxin refluxes through the upper genital tract, into the pelvic cavity and spreads the infection. Recent research from New York's Rockefeller University indicates that only those strains of *S. aureus* which show viral infection, are responsible for TSS.

This brings us to the question of the Indian market. Currently, four varieties of tampons are on sale in India. None are of the super-absorbent variety. Nonetheless, it is wise to follow certain basic guidelines when using tampons. Tampons should be changed frequently and pads used at night. It is advisable to use pads when using intrauterine contraceptives. When flow is scanty, tampons can be used. Tampon use should be suspended if any symptoms of TSS are noted.

Indu Vijayakar

Dr. (Mrs.) Vijaykar is a Professor of Gynaecology and Obstetrics at the Grant Medical College, Bombay.

Tampons on sale in India

CURRENTLY four brands of tampons are available in India. Manufacturers of all brands claim that the tampons are super-absorbent, though details are not given about the materials used in them. None of the brands make a mention of TSS.

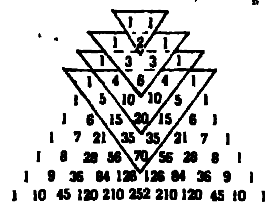
PIX, produced by P.H. Hira & Co, Bombay has been in the market for several years. Its tampons come in two sizes: Regular for average to light flow and super for medium to heavy blood flow. The super ones are just fatter plugs of the same material. The container-applicators are made of hard-bound paper. Number per box: 10; price Rs. 8.

COMFIT, manufactured by P.S. Products (Pvt) Ltd, Bombay under the licence of Christine Hoden, has been recently introduced into the Indian market. Its size and shape is similar to PIX but with a lubricated cardboard container-applicator. The leaflet enclosed even suggests the simultaneous use of two tampons during heavy bleeding. Number per box 10; price Rs 9

Ob, manufactured by Johnson & Johnson entered the market in the late 70s. The label on the package, claims that the "tampons are made of special fibres, which are woven together to remain intact. The compressed layers of highly absorbent material expand in width to give a snug fit". No applicator is provided. Number per box: 10; price Rs. 12.

Menes de Paris, manufactured by Caprisons, Bombay, is a relatively recent introduction. Each tampon is individually sealed and has a lubricated tip for easy insertion. No applicator is provided. Number per box: 10; price Rs. 10.50.

The Department of Trade, UK, has requested the Government's chemistry laboratory to analyse all sanitary products, including tampons. In the West, though there is no restriction on the sale of any tampons, certain brands have been banned and on others it is written: Tested for TSS.



Repeating series

CONSTRUCT any 3 digit or 4-digit number such that the product of the first two digits gives the rest of the number; and then multiply the first digit with the last digit of the number so formed to obtain the second number, and so on. After you construct a few numbers in this manner, a surprise is in store for you. The original number you had constructed gets repeated in the series. Caution: the digit zero is not to be used.

Consider the following series of numbers:

Case 1	Case 2	Case 3	Case 4
7321	**2816**	8324	9436
177	6212	**4832**	6954
717	2612	248	**4624**
7749	224	8216	4416
9763	428	6848	6424
3927	8432	8648	**4624**
7321	**2816**	8864	
		4832	

It can be seen that if the first two digits in the original number are both odd (as in case 1) or both even (as in case 2) the first number of the series itself is repeated. But if, in the first 2 digits of the original number, one is even and the other odd, then a number lower down in the series is obtained, and the series repeats itself from that point onwards. Cases 3 and 4 illustrate this. It is found that all these series repeat themselves only from a point where the first 2 digits of the number concerned are both even or both odd.

Some exceptional numbers like 111, 5525, and 6636 generate series composed only of themselves. Numbers with more than three or four digits like 129108, 12929, 219189, 21938, and so on, cannot be obtained again, but are at once reduced to 3-digit or 4-digit numbers in the first step itself, and the same conditions then apply.

In actual fact, there are 9 such series which repeat themselves as given below: 1) 111, 111, .. (2) 5525, 5525,... (3) 6636, 6636.. . (4) 9981, 199, 919, 9981,.. . (5) 4416, 6424, 4624, 4416,... (6) 133, 313, 339, 9327, 7963, 3721, 133,.. (7) 177, 717, 7749, 9763, 3927, 7321, 177,... (8) 224, 428, 8432, 2816, 6212, 2612, 224,... and (9) 248, 8216, 6848, 8648, 8864, 4832, 248...

All 3-digit or 4-digit numbers constructed in the above manner either can be found in these series themselves, or they lead up to one or the other of these repeating series.

Mala Janardhan

Ms Janardhan is a mathematics graduate from the University of Bombay

Interesting properties of 13

THE number 13, considered inauspicious by many, has a few mathematically interesting properties. Some of the mathematical terms like perpendicular, circumference, antilogarithm, approximation, indeterminate and quadrilateral have totally 13 letters in them. The square of 13 and when it is taken in reverse, that is 31 are 169 and 961 which are also in reverse order.

In the following table three digits which add up to 13 are taken. These are then taken as a number and squared. When the six digits of the square are added together taking them as blocks of two digits each, the number obtained is 169 which is the square of 13.

$13 = 8 + 2 + 3$; $823^2 = 67\ 73\ 29$; $67 + 73 + 29 = 169 = 13^2$.
$13 = 9 + 2 + 2$; $922^2 = 85\ 00\ 84$; $85 + 00 + 84 = 169 = 13^2$.
$13 = 3 + 2 + 8$; $328^2 = 10\ 75\ 84$; $10 + 75 + 84 = 169 = 13^2$

D. R. Kaprekar

Mr. Kaprekar is a retired mathematics scholar from Deolali Camp, Nasik

All encompassing series

A METHOD to obtain an all encompassing series of right angle triangles (Pythagoras re-visited, SCIENCE TODAY, September 1983) is given below.

Let one of the perpendicular sides be 'n' units (n being an integer) and the other perpendicular side be 'x', the hypotenuse being 'y'. It is evident that $n^2=y^2-x^2$, that is, $(y+x)\ (y-x) = n^2$.

Resolving n^2 into two factors (say p and q, p being greater than q), exhausting all the possible sets of the two factors and selecting those sets where both the factors are odd or even and solving the simultaneous equations $y+x=p$ and $y-x=q$, we get, $y=(p+q)/2$ and $x=(p-q)/2$

Let us take three examples where the perpendicular side is (a) 15 units (b) 16 units (c) 19 units

(a) $15^2=225=225\times1$ or 75×3 or 45×5 or 25×9 or 15×15.
Omitting the last set, we have $y+x=225$ or 75 or 45 or 25 and $y-x=1$ or 3 or 5 or 9. Solving the equations, we have, $y=113$, 39, 25 or 17 and $x=112$, 36, 20 or 8.
The series are 15–8–17, 15–20–25, 15–36–39; 15–112–113.
(b) $16^2=256=256\times1$; 128×2; 64×4; 32×8 or 16×16. Omitting the first and last sets and solving as above, we have the series 16–12–20; 16–30–34; 16–63–65.
(c) $19^2=361=361\times1$ or 19×19. Omitting the last set we have only one set yielding three sides as 19–180–181.

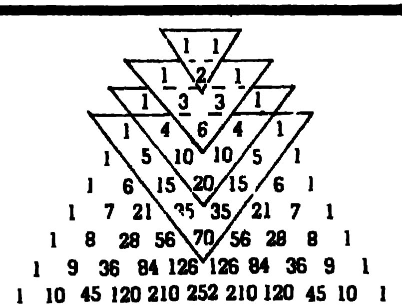
C. G. Subramaniam

Mr. Subramanian is a retired principal from Hyderabad.

Pascal's Triangle

ONE often encounters problems the answers to which are contained in the problems themselves, and can be drawn out if one knows where to look for them. The well known Triangle of Pascal shown alongside, provides a suitable frame for demonstrating how this happens in the context of the problem of determining the sum of the squares of the numbers in any given line of the triangle read horizontally. The answers can always be found at the apex of the inverted triangle of which the line in question is the base.

Examples: $1^2+3^2+3^2+1^2=20$
$1^2+4^2+6^2+4^2+1^2=70$



One is tempted to call this the Manchurian Key because the answers all lie in a vertical line one below the other as in a Chinese text.

A. R. Kanga

Mr. Kanga is a consulting engineer based in Bombay.

WELCOME TO

In the years to come no one can afford to remain ignorant about computers and their working, so profound is going to be the impact of these machines on mankind. We present a stimulating new series to draw you closer to the machines

SPEECH provided the first means for conveying information from man to man. Writing, by introducing a capability of storage, helped to record details for posterity and thus added dimensions of accuracy and reliability Though remotely located persons could now communicate, it was printing that made possible wide dissemination of knowledge in a permanent form However, all these revolutions relied only upon passive media The computer is the first medium that can not only store information, but also analyse it and make decisions The digital computer is, thus, often hailed as the fourth information revolution

Impact of the Computer Revolution

The capabilities that computers give us are virtually boundless Today we live in the computer age, and to a major part of mankind, the computer is virtually omnipresent in everyday life On one hand, the monthly telephone bill or a university marksheet comes from a computer But it is the same computer which also beats masters in chess or calculates the value of π to a million places Computers find applications everywhere in video games business calculations—most airline reservations are done through computers (and there is talk of computerising railway reservations also) When Apollo 11 landed on the moon the computers had done their job well and when Apollo 13 failed they had still been programmed to take care of eventualities and ensure a safe landing

Current trends only confirm the expectation that computers will be used more and more Technology is proceeding towards greater computer power in more varied applications The child of today takes electricity for granted and expects, say a light to go on when he presses a switch This was a miracle only a few decades back In the same manner it is quite conceivable that computers will become a part of our

COMPUTERLAND

S. Arun-Kumar R. Chandrasekar R. Ramanujam Kamal Lodaya Paritosh Pandya

A visit to a Computer Centre

When we enter the installation, the **first thing** we note is that it is air-conditioned (electronic components work efficiently only at temperatures below 20°C). All around we see sheets of paper perforated on either side—such **continuous** stationery is typical of computer output. The printers hold the paper on the perforated sides and automatically advance the paper after printing a line

We go and sit at a user terminal As we switch on, a message flashes on the screen

LOGIN PLEASE

In fact, whatever we try to type on the keyboard it insistently asks us to "login" Logging in to the computer is a process by which one identifies oneself to the machine Only after checking that an authorised person is using the terminal does a computer allow anybody to use it For this purpose usually each user is given a **password**, which he has to type in at the time of logging in.

Once this is done, the computer leaves us free to do what we like—we see if some friend is also logged in, exchange messages with her, ask for the time, create programs, make the computer execute them . When we are in a soup, we ask for help and sometimes detailed guidelines are available while sometimes cryptic codes appear We look at our **files**--the data and programmes of each user are kept in files in the area meant for that user We add information to files, edit existing ones, delete some

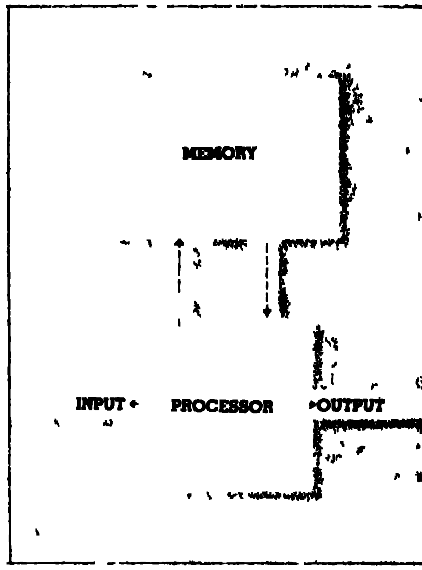
Finally, we 'logout' and the computer gives details of how much of each resource we have used up on the machine We go to the printer station and collect the output of some of our programs and leave the centre (Each installation normally has one or two printers and many terminals)

everyday lives in a not very distant future

Many sociologists feel that mankind is becoming too dependent on computers and stories abound in science fiction of computers that take over the world We often hear the question Can computers think?" We will have more to say on this interesting subject later on in this series for the present, let us dismiss all these notions and remind ourselves that the computer is only a **machine,** just like a lathe or a steam engine

The Computer — Conceptual

A computer is an **information processing machine.** It takes in some information, which is called its **input,** analyses it and produces information which we call its **output** Further, it also stores some of the information in what is referred to as its **memory** In general, the output of a compu-



ter is determined by its input and its memory The part of the computer that processes information is called the **processor.**

The word *information* is used here in the broadest sense Any meaningful symbol can be said to have some information content. The input to the computer consists only of symbols— some of these are interpreted as **instructions** and the rest as **data** The processor simply carries out these instructions on input data (perhaps using memory) and produces output results. Both data and instructions can be stored in the memory.

Consider, as an example, a computer that has only the number *2* in its memory It gets the input *ADD 5 TO MEMORY* Here *5* and *2* should be taken as data and *ADD* as instruction As only to be expected the processor would find 7 to be the answer and give it as output

If the computer only interprets information and processes it, how does it handle different types of information? How can the same processor manipulate numbers as well as say names or chess moves? In fact all input to the computer is *coded* into one standard form in which it is stored and analysed and data is output only after *decoding* into the original form

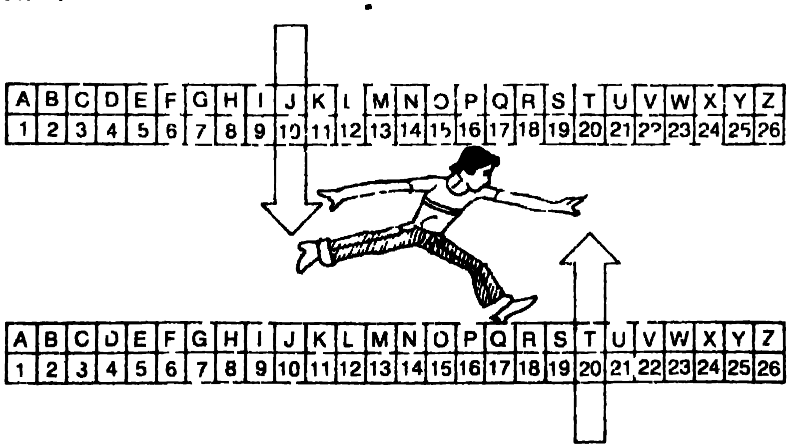
For example let us code the letters *A* to *Z* by numbers from 1 to 26 To answer the question

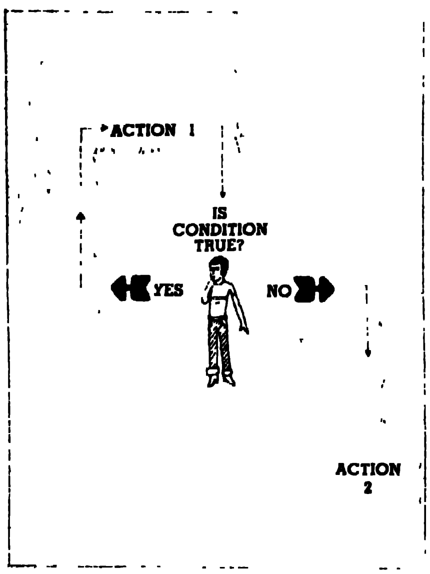
Which is the tenth letter after J?

we only need to find the code for *J* (which is 10) add 10 to it and decode the result *20* to get the answer *'T'*

In digital computers all information is coded into numbers We as human beings find it convenient to use decimal notation

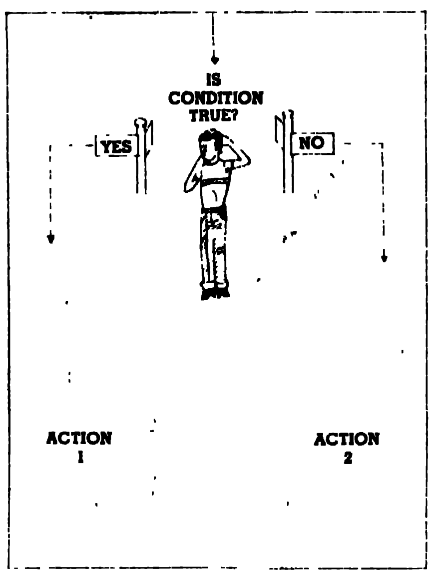
Q WHAT IS THE 10TH LETTER AFTER "J"?
A: 'T'





for numbers, whereas computers use *binary* digits, called **bits,** for representing numbers. A bit can have value either *0* or *1*. Since each bit can have two values, n bits together can have 2^n values and thus can represent numbers from 0 to $2^n - 1$. To give an example, decimal 13 ($1 \times 10^1 + 3 \times 10^0$) would be represented as 1101, i.e. ($1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$) in the binary system of numbers. Computer memories store numbers in terms of **bytes,** each of which is a group of 8 bits, and **words,** which are convenient multiples of bytes. (By the way, how would you count upto 1023 on your fingers?)

If information is converted into numbers, we would expect that the processing done by the computer would be only arithmetical. This seems disappointing when we consider only operations like addition, subtraction, multiplication, division etc. But we can do more with numbers—we can compare them and say one is greater than, or less than, or equal to another. We can use *and, or, not* etc, and build complex *logical* conditions and check whether they are true or not. Further, we can build



compound operations like
IF *condition is true* THEN
add 2 and 2
ELSE
subtract 5 from 10
which are called **conditional instructions,** or those like
REPEAT *add 5 to x* UNTIL *x > 100* which are known as **repetitive instructions.** In general, any computer understands a fixed set of such instructions. A group of specific instructions put together is called a **program.** The form in which they can be put together is specified by a **programming language.**

A program can be compared to a recipe. The data may be various ingredients like rice, peas etc. The recipe would be a sequence of instructions specifying a method for cooking, for example—(add water to rice, boil, add peas) etc. The process of designing such recipes (programs) is called **programming.** Just as we follow the recipe and perform these actions to produce *pulao,* the computer **executes** the program on the given data to produce output. And as a cook has a collection of recipes to prepare various delicacies, a computer has many programs which tell it what to do and how to do it—these are collectively called its **software.**

To summarise, a computer can be understood as a machine which accepts programs and data as input and executes the programs on the given data to produce output.

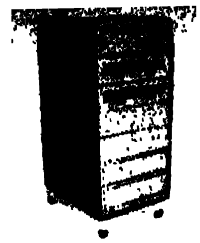
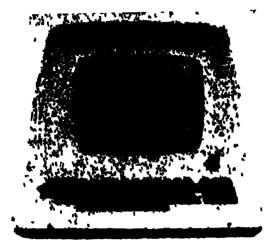
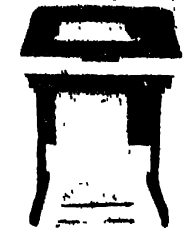
The Computer — physical

We now have a conceptual idea of what a computer is. The machine itself is built using electronic circuitry and mechanical devices, which are called its **hardware.** For example, a bit is represented by a voltage level, LOW indicating 0 and HIGH indicating 1. Changes in data are thus only setting various voltages. Computation is carried out by circuits which examine input voltages and set output voltages correspondingly.

Input is generally given through keyboards, teletypes, punched cards, paper tapes etc. Output is taken on printers, video terminals etc. (See box on page 47). Memory is normally made of magnetic core or Integrated Circuits ICs This is called **primary memory.** However, to store large quantities of data, it is more economical to use magnetic tapes and disks; these are known as **secondary memory.** Input/Output (*I/O*) and memory devices are collectively referred to as **peripherals.** The processor is also made of ICs. We will study the inner

From 'mighty micros' to mammoth mainframes

	Mainframe	*Mini*	*Micro*
Size	Occupies a large hall	Occupies a small room	Desktop
Cost (Rs lakhs)	Over 50	Around 10	Around 1
Use	General purpose	Environments with not many users	Plug in's Personal computers
Typical applications	Commercial, industry and University (large data)	Business Special-purpose	Instrumentation Control Systems Recreation
Operating staff	Specially trained	Programmers	Novices
Design feature	Performance at the cost of complexity	Reliability, low cost, small size	Ruggedness, simplicity, low cost

organisation of a computer in detail later on.

Though three decades ago each computer was so huge as to occupy large rooms, today they are available in desktop and pocket sizes. In a later issue, we will see how this evolution has taken place. The trend in hardware technology seems to be to continually look for smaller computers with greater processing power.

That raises the question: "How do we characterise the processing power of a computer?" The following are important parameters

(i) speed—the number of instructions it can execute in a second (typically, any computer can do about a million additions in a second).

(ii) memory—the number of bits of information that can be stored in primary and secondary memories (typically of the order of millions of bits).

(iii) data throughput—the number of blocks of data that can be transferred in a second between primary and secondary memory.

(iv) word length --the number of bits in a word (this affects throughput as well as processing speed)

Usually, the number of peripherals that can be connected are also specified for a given computer system.

The way computers have evolved suggests a broad classification of computers into **mainframes, minicomputers** and **microcomputers.** There is no precise definition characterising each class, but there are some points of comparison (see box on pg 46)

Peripherals

Peripherals can be classified as Input, Output and Input/Output devices. Input devices like paper-tape readers and punched card readers are used only to feed information into the computer. Card punches, Paper tape punches, plotters, line printers, character printers are examples of output devices. Among input/output devices, we have magnetic tapes, floppy diskettes and hard disks, which are used for long-term storage, as well as text and graphic terminals, which do not have storage capability.

Card punch/Punched-card reader: Like the presence of holes in a bus ticket indicates the source and destination of travel, holes in cards are used to transmit information to or from the computer

These cards are thin, stiff and contain 12 rows and 80 columns of hole-positions. The presence of one or more holes in a column represents the code for some character (A *character* is a letter of the alphabet, a digit, or a punctuation symbol) A card punch takes in letters or digits from the computer and punches the corresponding holes on a card. A punched-card reader passes this card under brushes which sense the holes and decode the information contained in the card Typically, card readers can read about 1,200 cards/minute

Paper tape punch/Paper tape reader: Paper tapes work on the same principle as punched cards. One inch wide, long ribbons of paper with holes on them are wound into reels. Paper tapes are easy to handle, but are liable to damage

Line Printer/Character printer: Generally known as **hard-copy,** a printed output sheet is about 60 lines long, each line having 132 print positions. Line printers print a line at a time, having 132 bars or wheels consisting of type-faces for all characters, whereas character printers have only one such mechanism and move horizontally across the line printing one character at a time. Of the latter variety, dot-matrix printers do not have a special type-face for each character, but build each one using dots. Printer speeds vary between 300 to 1,200 lines/minute.

Text/Graphic terminals: A terminal is a typewriter-like keyboard connected to a television-like screen. We type in information and see results appearing on the screen Graphic terminals allow drawings also to be shown on the screen or input with special 'pens'.

Magnetic tape drives: These store or retrieve information from a 'magnetic-tape' just like a cassette recorder records or plays music on/from a cassette, selectively magnetising the tape surface. Magnetic tapes are cheap and efficient, since each 2,400 feet reel of tape contains the equivalent of about 50,000 punched cards.

One disadvantage of these tapes is that they provide only *sequential access* to information, that is, like cassettes, they allow access to information only in the order in which it was recorded.

Disk drives: In a record player, one can play any piece of music on a record by just lowering the needle to the desired place. In such *direct access* devices information can be accessed in any order, irrespective of the order in which it was recorded.

Hard-disk drives: use multiple heads and constantly rotating recording surfaces. Information is recorded or sensed magnetically on these surfaces A hard-disk drive with 10 heads and 20 surfaces can store about 200 Megabytes of information. (A byte is a group of eight bits, a Kilobyte is 1,024 bytes, and a Megabyte is about a million bytes.)

Floppy diskettes: are small, flexible disks about the size of a *papad* (diameter approximately 5" or 8") The operation of floppy drives is similar to that of hard-disk drives An 8", single-side, single-density floppy disk stores about 250 kilobytes of information More easily portable, floppies are normally used in microcomputers.

Computer Science

The discovery of the practically unlimited potential that digital computers offer has led to extensive scientific study of the behaviour of these machines It has gradually emerged as a field of science and technology in its own right--nowadays we speak of Computer Science, which is the formal study of computer software and hardware

The electronic computer itself being essentially a post-war phenomenon, Computer Science has not yet turned forty. However, there is already a wealth of interesting material for study in this area In this series we hope to give the reader a flavour of the ideas in the field. □

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RAMANUJAN— MATHEMATICIANS' MATHEMATICIAN

A natural mathematical genius, Ramanujan started the tradition of modern mathematics in India

Srinivasan Ramanujan—1887 to 1920

MASTERING Loney's *Trignometry* at the age of 12, verifying and rediscovering the formulae of Carr's *Synopsis of Pure and Applied Mathematics* at 15, and identifying number 1729 as an interesting number (it is the smallest number expressible as the sum of two cubes in more than two ways, $1729 = 1^3 + 12^3 = 9^3 + 10^3$) when seriously ill in bed, are no mean feats But to Srinivasa Ramanujan it was all like playing with friends Numbers were his friends

A natural mathematical genius, Ramanujan started the modern tradition of mathematics in India which had produced no major mathematician during the previous eight centuries and, in an environment where most intellectual activity was confined to mysticism, sterile reinterpretations of old religious philosophies and to fine arts The last great Indian mathematician before Ramanujan was Bhaskacharya (c 1114 to 1185). Though there was an air of mysticism even about the way Ramanujan did his mathematics (he at times claimed that solutions had been dictated to him by a goddess in dreams and frequently came up with major theorems without proof), his stupendous achievements gave a major impetus to the pursuit of rational intellectual activities in India.

That Ramanujan should have come up with brilliant insights into some of the most profound problems in mathematics, or even thought of these problems, without the advantage of a formal training or the stimulus of a living mathematical tradition, remains an unexplained enigma This fact has, however added further lustre to his image as a mathematical hero

Ramanujan's life sketch is both tragic and funny He was born in a poor orthodox, Brahmin family at Erode, in Madras Presidency on 22 December, 1887 His father kept accounts for a cloth merchant At school he immediately revealed his inborn mathematical genius and his prodigious memory After passing the matriculation examination in 1903 in first division, Ramanujan obtained the Junior Subrahamanyan Scholarship for pursuing a college education at the Government College, Kumbakonam. But his excessive preoccupation with mathematics led him to neglect other subjects He failed twice in the Intermediate examination and lost his scholarship. But his zeal for mathematics did not diminish He continued his studies independently at home "jotting down his results in good-sized notebooks "

In 1909, he married Janaki Ammal, aged nine and then he decided to take up a job. His father could hardly afford his education Those were the days of utter poverty for Ramanujan But friends and admirers were many and he was given a letter of recommendation to Devan Bahadur Ramachandra Rao, the then Collector of Nellore and the President of the Indian Mathematical Society The latter immediately recognised Ramanujan's genius. Thereafter, Ramanujan began to receive a money order of Rs 20/- every month from the Divan But after about eight months he refused this amount and requested the Divan for a job. In March 1912, he got a clerical job in the Madras Port Trust Here his mathematical abilities were immediately recognised by his peers and friends His name was recommended to the University of Madras for a fellowship and thereafter from May 1913, a monthly stipend of Rs 75/- was awarded to him.

Flowering of Ramanujan

Then started the friendship with Prof. G H. Hardy, of the University of Cambridge, England, who was one of the best pure mathematicians at that time. Ramanu-

jan had begun correspondence with Hardy on the advice of some of his friends. Hardy's discovery of Ramanujan is an oft-quoted story, wherein all characters come out well, but two. As C P Snow writes about Hardy in *Variety of men*: "One morning early in 1913, he found among the letters on his breakfast table, a large, untidy envelope decorated with Indian stamps. When he opened it, he found sheets of paper, by no means fresh, on which, in a non-English holograph, were line after line of symbols. Hardy glanced at them without enthusiasm. He was by this time, a world famous mathematician. . unusually exposed to cranks... The script appeared to consist of theorems, most of them wild or fantastic-looking, one or two already well known, laid out as though they were original. There were no proofs of any kind. Hardy was not only bored, but irritated. It seemed like a curious kind of fraud. He put the manuscript aside, and went on with his day's routine."

"But the Indian manuscript nagged him in the course of his daily routine. Wild theorems. Theorems such as he had never seen before nor imagined. A fraud or genius. He sent word to Littlewood . Before midnight they knew and knew for certain, the writer of these manuscripts was a man of genius. That was as much as they could judge, that night."

It was later that Hardy decided that Ramanujan was, in terms of a natural mathematical genius, in the class of Gauss and Euler. However, Hardy was not the first mathematician who received Ramanujan's manuscripts. Two eminent English mathematicians before him had returned them without credit!

In 1914, Ramanujan came to England and then bloomed a friendship, both touching and rewarding. Hardy taught him some formal mathematics, as if he were his student- not an easy task, when the student is a genius. Hardy was always perplexed and cautious. "What was to be done in the way of teaching him modern mathematics? The limitations of his knowledge were as startling as its profoundity . All his results, new or old, right or wrong, had been arrived at by a process of mingled argument, intuition and induction of which he was entirely unable to give a coherent account." During this time, it is probable that Hardy learnt more than Ramanujan. And together they produced five papers of the highest quality.

According to Hardy, "His friend and collaborator Prof J. E. Littlewood was a much more powerful mathematician than he was and his protegé Ramanujan had absolute natural genius, comparable to that of the greatest mathematicians." In *A Mathematician's Apology* he says, "I still say to myself when I am depressed and find myself forced to listen to pompous and tiresome people, "Well, I have done one thing you could never have done, and that is to have collaborated with both Littlewood and Ramanujan on something like equal terms"

In nature, Ramanujan was a simple, unassuming man, very obedient to his mother and loving to his wife. He never used to call his wife by her first name but used to address her as *veettukari* (my house) Rs 60 per month was religiously paid to his mother during his stay abroad. Always kind and gentle to his friends, he was often sensitive to an extreme, cooking on his own in his rooms in England. There is a funny incident with Prof G C Chatterji, former Vice-Chancellor of the Rajasthan University when he was in England. Ramanujan had invited the Chatterjee's and some of his friends for dinner in his Trinity rooms. The dinner was prepared by Ramanujan himself with great care.

However, when the Chatterjee refused the third helping of the soup prepared by Ramanujan, he suddenly disappeared from the house. He stayed away for five days because, in his own words, "I felt hurt and insulted when the ladies didn't take the soup I served. I went out in despair and did not want to come in while they were in the house."

In 1918, the Royal Society elected Ramanujan as a Fellow and in the same year Trinity also elected him a Fellow. He was awarded the distinguished title of FRS (Fellow of the Royal Society) at the age of 31, and the study room of Isaac Newton in the Royal Society, which was normally kept locked, was made available to Ramanujan. England showered on him all the honours that were possible, while probably in India he would have led an uneventful existence.

In England, Ramanujan showed interest in "what was unexpected, strange and odd; he had quite a small library of books by Circle Squarers and other cranks" says Hardy and even published in the *Journal of the Indian Mathematical Society* (1913), an article titled 'Squaring the Circle'.

Though a substantial part of Ramanujan's work is devoted to rediscovery of ideas which were already worked out or known, many of the mathematical problems put forward by him continue to baffle the mathematicians even today. Curiously, though they have not been proved, they have not been disproved either.

Ramanujan's noteworthy contributions were his 'algebraic approximations of (π), his theory of partitions and the allied parts of the theories of elliptic functions and continued fractions." The idiosyncracies of all numbers were known to him and 'every positive integer was one of his personal friends'.

In spring of 1917, Ramanujan fell ill. Apparently, the harsh English climate did not suit him well. In 1919, he returned to India but soon died of tuberculosis at Madras on 26 April 1920 when he was not even 33 years old. Hardy wrote an appropriate epitaph: 'Galois died at 23, Akhel at 27, Ramanujan at 32, Rieman at 40. I do not know an instance of a major mathematical advance initiated by a man past 50"

B. S. Mahajan

[illegible]

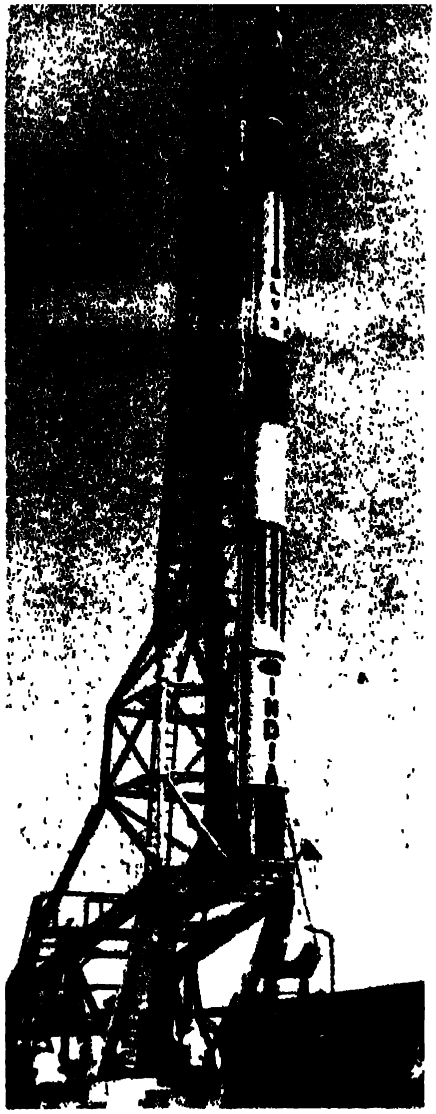
M[illegible] in the theory of numbers, [illegible] is considered as the [illegible] branch of modern mathematics.

In 1917, Ramanujan developed a formula for the partition of any number which could be made to yield the required result by a series of successive approximations. For example, for any positive integer n denoted by $P_{(n)}$, the number of partitions of n is the [illegible] of ways of splitting n into sums of positive integers.

The game of partitioning numbers into sum of squares, cubes and higher powers was started in early 1770 by E. Waring and Ramanujan was an expert in it. At any time, stored in his memory were every characteristic power and root of not less than 10,000 integers. In short, he characterised each number and was on intimate terms with each number of the series.

Ramanujan's contribution to the [illegible] tion of [illegible] and highly composite numbers and prime factors. The representation of numbers as the sum of squares is considered as a significant contribution. However, his efforts on the prime number theorem, conjectured first by Legendre and Ga[illegible] and finally proved by Hadamard and de la Valli Puisson in 1876, are considered noteworthy. The very form of the theorem was constructed by his independent efforts.

Ramanujan's efforts in algebra were in hypergeometric series and in continued fractions. So great are his contributions that several functions, identities and hypotheses bear his name. Often mathematicians claim that his work, besides bearing the mathematical permanence and truth, had an aesthetic quality of its own. "The domain of his work could well be called mathematical aesthetics".



EYE OF THE ROHINI

T. K. Alex
K. K. Kurian

ROHINI-D2 is probably the smallest satellite with a remote sensing payload capable of imaging the Earth in two spectral bands. The spacecraft weighing 41 kg was built at the Indian Space Research Organisation's (ISRO) Satellite Centre at Bangalore and was launched by the Indian rocket SLV3-D2 from Sriharikota on April 17 last year. The major experiment in this mission is a small camera called "Smart Sensor".

The picture data from a satellite is transmitted to ground station in the form of electrical pulses (as in the case of the Morse code) The rate at which these pulses are sent from satellite to ground station (called "downward data rate") is measured in bits per second. The downward data rate for Rohini-D2 spacecraft is 32 kilobits per second.

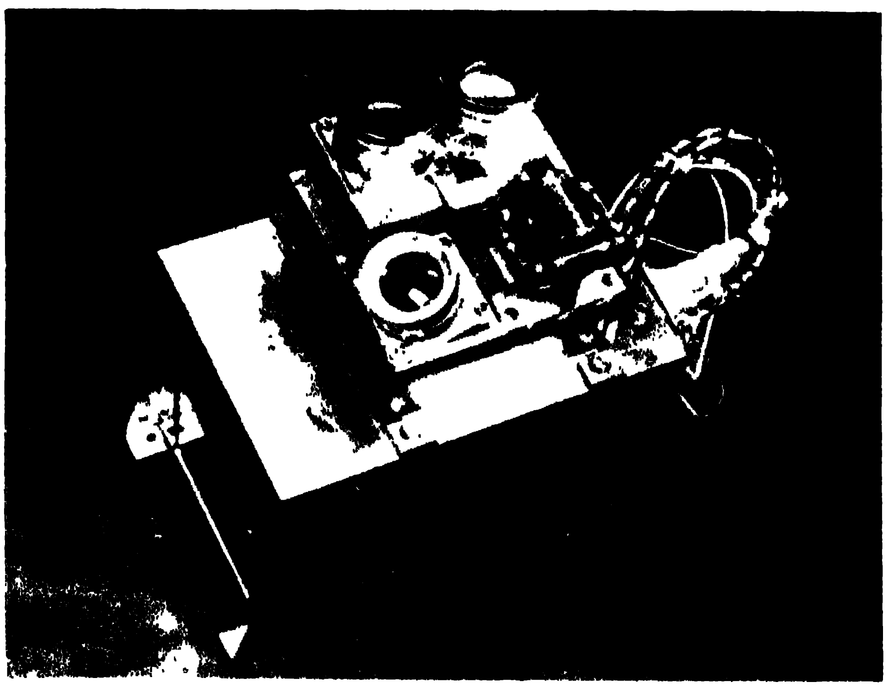
Unlike conventional sensors, smart sensors have "in-built intelligence" for on-board decision-making. They process data on-board and transmit only useful data. This not only reduces the downward data rate, but also helps weed out the undesirable data at the source.

Other smart sensors can activate an on-board system under favourable conditions without waiting for a ground command. For instance, such a camera operates only when there is sufficient ground illumination and when the satellite's "health"—its systems are working safely, it stops taking pictures if the area is covered by clouds. A satellite then does not have to wait for a ground command about "what to do next". This in essence is the "smart" technique where human intervention is minimal and actions quick and precise.

The advent of these intelligent cameras comes in the wake of advances in solid state technology Microprocessor based systems and solid state imaging devices are routinely being used in space missions these days and various types of smart sensors have been successfully tried by National Aeronautics Space Administration (NASA) and other agencies. The smart sensors are vitally important in unmanned space missions, particularly in the long-range planetary probes and also in small satellites like Rohini where weight and electrical power requirements pose severe constraints.

The smart sensor in Rohini-D2 satellite has two lenses. One allows red light which is in the spectral band of 600-700 nanometers (nm). The other allows infra-red radiation in the spectral band of 800-900 nm. Thus the camera is capable of taking pictures in two bands. But these are not transmitted simultaneously. The sensor compares on-board the two pictures and generates a classified picture called the "feature picture". The feature picture contains only four important ground features namely, water, vegetation, bare land and cloud/snow. It is this capability of the sensor for on-board classification of ground features which renders it "intelligent".

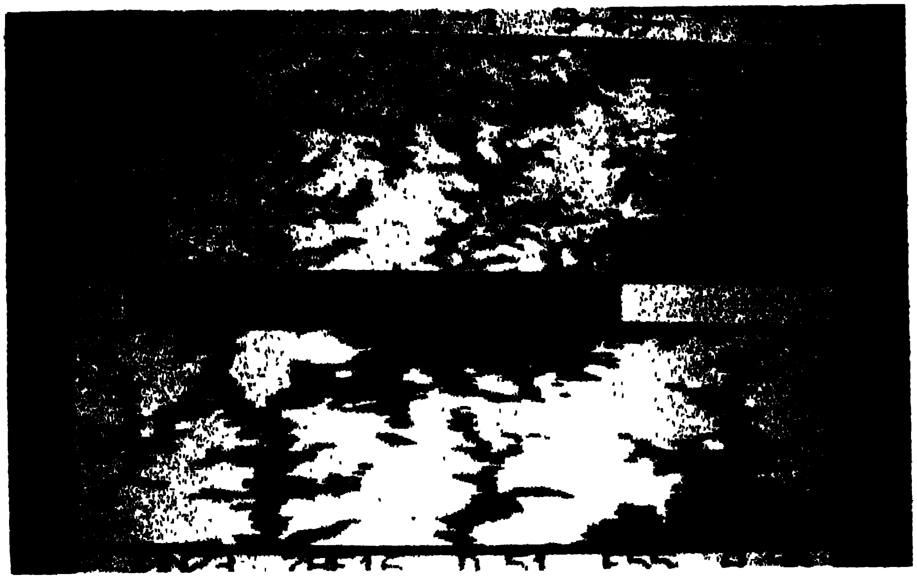
All set for the launch. **Left:** ***The satellite Rohini-D2 perched atop SLV3-D2 rocket at Sriharikota.*** **Below:** ***Close-up of the two-band smart sensor camera which is carrying out a major part of the Rohini mission***



The images of the earth from space reveal the world-wide interaction of man and his environment in a uniquely comprehensive way. They provide an unrivalled global perspective

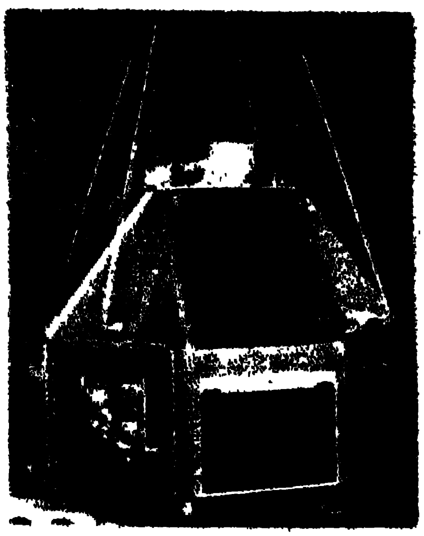
The sensor comprises two solid state cameras, a horizon crossing sensor and a sun sensor. It is a very compact arrangement weighing less than 2.4 kg. The peak power requirement is 4.5 Watts. Because of power constraints, the camera cannot be operated continuously. The system is turned on for 15 minutes and switched off before it leaves the visibility of ground station. As a safeguard there is also an automatic timer switch-off facility which comes into play if the switch-off command from ground station fails to work.

Before the camera is turned on, certain parameters are checked. Only daytime land passes with sufficient brightness are selected for operation of the camera. But ideal conditions are



Views no bird can provide: Fig. 1: snow-covered Himalayas **(above)** *and Fig. 2:* **(below)** *the coast of Kerala as seen by the smart sensor.*

The Rohini-D2 satellite. Arrow shows the optical head of the camera projecting from the belly band solar panels.



not always available. Mission control has also to determine that other conditions like the health of the satellite—power, temperature, etc—are favourable before the payload operation is conducted. The satellite orientation and spin rate have also to be checked and the necessary corrections are to be applied if needed.

Rohini-D2 is a spinning satellite with its spin axis perpendicular to the orbital plane *(see diagram)*. The optical axes of the cameras are aligned normal to the spin axis. As the satellite rotates, the field of view (FOV) of the camera sweeps the Earth in every spin. The horizon crossing sensor generates a pulse when the camera is looking at a spot 4.5 degrees away from the local vertical. This scan-start pulse initiates an on-board memory to store data from the cameras. At the time of occurrence of scan start pulse, the line array will be viewing a scene marked A_1 to A_{256} in Fig. 3. The signal from the line array is sequentially switched and a series of analog voltage pulses are obtained. The

analog voltage is converted into digital signals and stored in the memory. Normally, this operation takes two milliseconds (known as integration time of the system). By this time, the satellite has turned and a new scene, marked as B_1 to B_{256} on the diagram, appears for imaging. This second line image also is stored followed by a third line and so forth upto 80 lines. In this way, a picture PQRS of an area approximately 250 km by 80 km is stored in the memory. The stored image is transmitted to ground station in 4.8 seconds and the camera is set ready for taking the next picture. The pictures are received at the rate of one picture per spin. These pictures joined together to give a contiguous picture of 250 km swath width. (A typical picture mosaic obtained in 118th orbit of Rohini-D2 is shown in Fig. 5.)

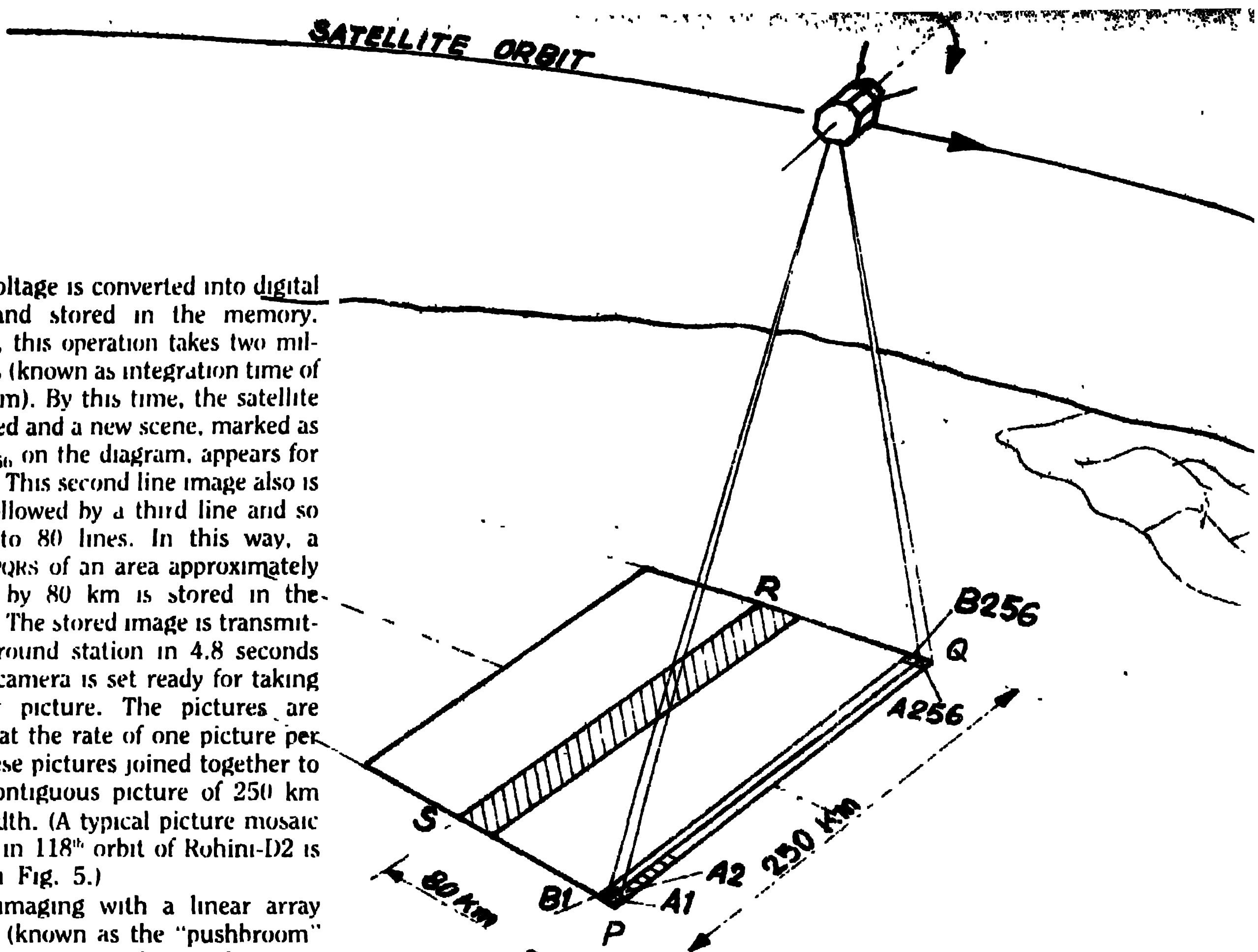


Fig. 3 Scan geometry of the smart sensor

Such imaging with a linear array detector, (known as the "pushbroom" technique) is among the simplest ways of imaging. The sensor is devoid of a shutter or any mechanical moving system. Except for the spectral filters, both the cameras are identical and view the same scene. In the normal mode of operation, a picture taken by the visible camera is transmitted. The infra-red channel can be selected by a ground command. However, both the camera outputs—visible and infra-red—are used on-board for comparing and generating the feature picture which is transmitted along with the normal picture. This offers several advantages. Different ground features reflect sun's radiation differently. For example water has more reflectance in the red region than in the infra-red region whereas vegetation reflects more in the infra-red region than it does in the red region. The pictures taken in different spectral bands can therefore provide us better judgement about the nature of ground features than can be had from a single panchromatic (normal black and white) picture.

A camera on a satellite can collect enormous amount of data. In smart sensors, special electronic circuits are provided which can identify useful data from data that are of no relevance to the mission. These sensors will transmit "only useful" data, ignoring the irrelevant data like clouds etc.

The picture data is actually an analog electronic signal, with different voltage levels as in the case of a television signal. These analog voltages are converted into digital signals or bits (in pulses of zero or high level) and stored in on board electronic memory. Telemetered data is received as a series of "words". Each word consists of seven bits. Out of these, five bits tell about the voltage level corresponding to a single picture element (called pixel). The other two bits tell about the nature of the ground feature. Thus, the picture as well as the feature picture are telemetered in a single stream of bits, suitably coded. The data is decoded in the ground station to separate the picture and the feature picture using a computer.

The field of view of the camera (the look angle) is fixed. As the height increases, the area covered by the camera look angle also increases. At a nominal height of 500 km each picture element corresponds to one km, that is, the resolution is one km. If the height is increased to 1,000 km the resolution becomes approximately two km. The resolution can also vary if the satellite is inclined to its normal position (tilted case).

Rohini-D2 has a highly elliptical orbit. Its altitude varies from 4,000 km to 860 km. As a result, the ground resolution varies from 0.8 to 1.7 km in the "cross track" direction. The resolution "along-track" direction again depends on the spin rate and the integration time selected. The normal rate of spin is between six rpm and eight rpm. However, the satellite can be spun up or down as desired by suitable ground commands.

Single band imagery together with a feature picture has a wide range of applications in the field of remote sensing. The picture gives you the details of the area covered such as the extent of vegetation inland water bodies and cloud coverage over selected regions (Fig 4 shows a typical map drawn using smart sensor pictures showing the area under vegetation in South India.) Pictures obtained from

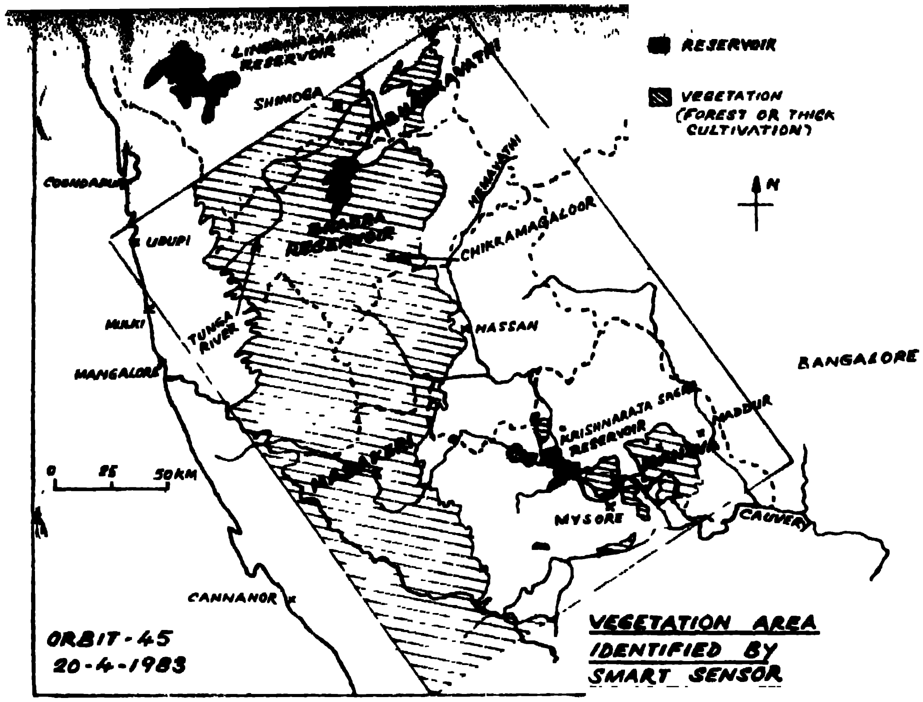
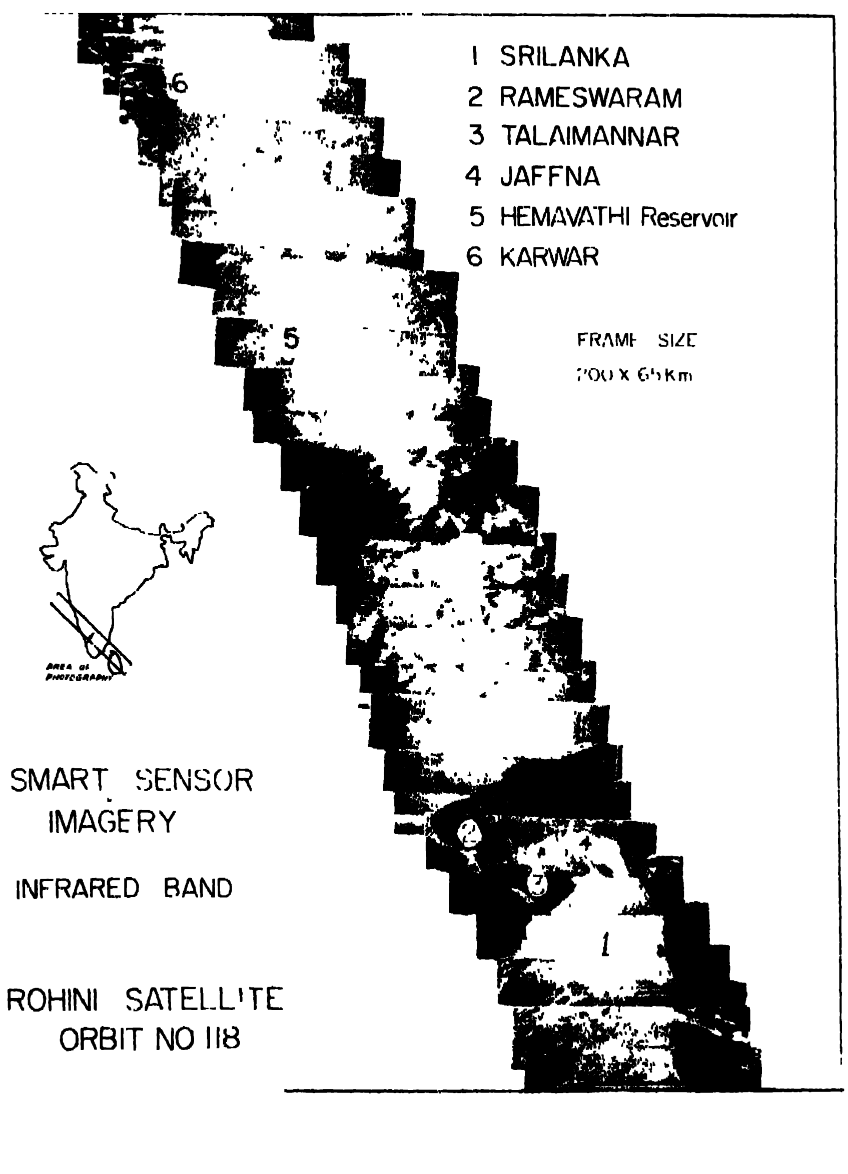


Fig. 4 Checking vegetation cover in South India

Fig. 5 A typical picture mosaic obtained in a single orbit of Rohini-D2 satellite



identical ground cover passes at different times are useful for studies of seasonal variation of ground feature. Pictures generated after ground computer processing can provide further details like the density of vegetation and soil types.

Another potential use of these pictures is to identify known landmarks and use the data for refining satellite orbits and altitude data *(see diagram)*. This is one of the latest techniques used in Earth-looking satellites. This goal was successfully accomplished by using landmarks (ground control points) and the orbit and altitude data are being improved.

In the very first two months, the satellite completed more than 900 orbits and beamed approximately an equal number of picture frames. More than 90 per cent of the Indian subcontinent was covered in these passes. The raw pictures obtained in these passes are further processed and annotated pictures were generated, with geometrical and radiometric corrections. (Fig. 1 and 2 show a set of the photographs of different areas of Indian territory.)

Rohini-D2 serves as a platform to test many new technologies in a single flight. The smart sensor technique is successfully tested in this flight and all the mission goals of the camera system have been met The technology of remote sensing using solid state detectors has started a new generation of sensor systems. The smart sensor in Rohini is leading the way to the development of advanced sensor systems in the Indian Remote Sensing Satellite (IRS) to be launched in 1986 which will have a capability to image the country with a spatial resolution of better than 40 metres in four spectral bands. □

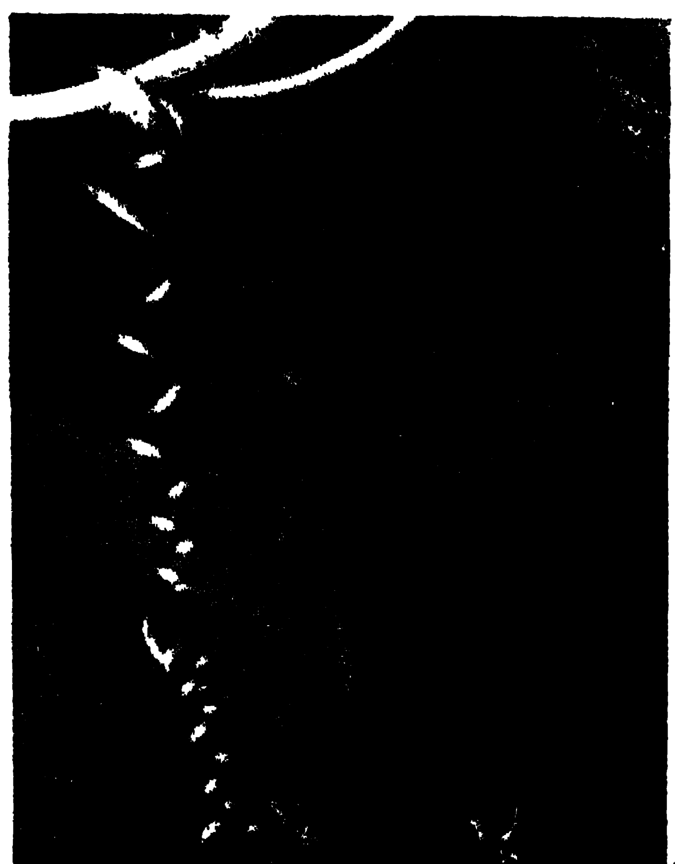
T K Alex is the Principal Scientist of Smart Sensor Experiment in Rohini Satellite Presently he is the Project Director for the Remote Sensing Experiment in the Joint Indo-Soviet manned space flight

K K. Kurian is the Chief Designer of the Camera System and the Electronics of the Smart Sensor Camera. He was responsible for the development of a similar camera in Rohini - D1

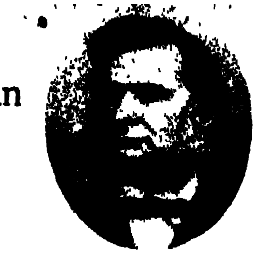
DARWIN ON DARWIN

WHAT are the origins of knowledge and the well-springs of human creativity? How did the best of scientists manage to make the contributions they did? Can we learn from the autobiographies of the great, how circumstances and incidents in their lives helped them in making their discoveries? In the late 1960 s when James Watson chronicled his personal view of how the structure of deoxyribonucleic acid (DNA) was discovered, in "The Double Helix", the book received extensive notices. Prof. Gunther Stent in a self-admitted act of "derivative, second-order scholarship" reviewed half a dozen reviews and noted that if one only read those, one would find it difficult to say that all the reviewers had read the same book, implying that no two persons perceive things exactly alike. (Of course, this point has been made even by moviemakers as in *Rashomon* (1950) by Akira Kurosawa who tried to convey the message that our memory regularly plays "tricks" on us since different persons in the movie viewing the same events recounted them differently.) Biologists also find that the human mind is not just a high fidelity recording machine and that between the sense reception and storage in the memory, there may be a selective destruction of

Down House* (above) *the home of Charles Darwin* (inset). *Wild plants like the Bee Orchid* (below left), *White Bryony* (below right) *and the Pyramidal Orchid* (facing page), *which grew in abundance at Down House in Kent, provided Darwin with the living proof of his contention that species could change by the process of "Natural Selection".



"Charles Darwin and Thomas Henry Huxley Autobiographies." Edited with an introduction by Gavin de Beer. Oxford University Press 1983, pp. 123, Price £2.50



information In the introduction to "Autobiographies of Charles Darwin and T.H Huxley", the editor of the book Sir Gavin de Beer quotes Huxley, "Autobiographies are essentially works of fiction, whatever biographies may be " In spite of this forewarning, the *Autobiographies* provide illuminating sidelights on various aspects of the lives of the two great scientists and even include lessons in scientific creativity

So much has been written about Darwin that it is refreshing to read what the man has to say about himself and his scientific discoveries As his books go, this is a relatively slim volume with less than 100 pages of his autobiography in it. Even this we may not have had if a German editor had not asked him to describe the development of his mind and character The outline of Darwin's life is well known Born 1809, he received his Bachelor of Arts Degree in 1831 and was to become a clergyman when he was offered the post of an unpaid naturalist aboard *H M S Beagle*. That literally changed the course of his life. The five-year voyage around the world brought home to him the point that species are not immutable as was becoming apparent to him from fossil and adaptive evidence But what was the mechanism of this change? There was a pause and after reading "Malthus on Population ', a bright idea came that favourable variations would be preserved and propagated and unfavourable ones eliminated According to Sir Gavin, however, Darwin already had the idea of the importance of selection in speciation as is borne out from his First Notebook written at least six months before his reading of Malthus Thus he had either forgotten about it or was 'overcrediting Malthus

In 1842 Darwin prepared the initial 35-page abstract of his theory which was then enlarged to 230 pages in 1844 In 1856, Lyell advised him to document his views fully He started to do so, but in 1858 he received an abstract from Alfred Wallace proposing an essentially similar mechanism of natural selection for speciation At the request of Lyell and Hooker, an extract from Darwin's essay along with that of Wallace was published According to Darwin, the two publications went practically unnoticed and the only published comment they received was from Prof Haughton of Dublin who said that "all that was new in them was false and what was true was old" The moral of the story was that things had to be explained at length Therefore, Darwin prepared a volume on the Transmutation of Species which was published in 1859 Darwin must have been pleased with the reception the "Origin of Species" received for he states that till 1876, in England alone 16,000 copies of the book were sold. It was translated into every major European language and an essay appeared in Hebrew which claimed that his theory was contained in the Old Testament.

In concluding his "Origin of Species" Darwin anticipated that, "light would be thrown on the origin of man and his history". In his autobiography, he clarifies that this was written with the intention of of emphasising his views that man and his mind were not exempt from the forces of evolution and natural selection. And in his usual manner, he went about collecting evidence and published his "Descent of Man" in 1871 As an aside, it should be mentioned that Wallace's views on the question of the evolution of the human mind were not the same as those of Darwin and were somewhat mystical Darwin's book on, the "Expression of the emotions in men and animals" was published in 1872 and this became another chartbuster It sold 5,267 copies on the day of its publication'

So, what was Darwin's secret of success? Fortunately, here he gave his own opinion of what he considered his strengths and weaknesses "I have no great quickness of apprehension or wit which is so remarkable in some clever men, for instance Huxley" He, however, thought that he had an extensive, although somewhat hazy memory In response to some critics who said, "Oh, he is a good observer but has no power of reasoning" he defended himself by saying that the 'Origin of Species" was one long argument which had successfully convinced a number of able men and which also established his power of reasoning He also claimed for himself a fair share of common sense and invention He was a careful observer and industrious in collecting facts More than that he professed his love for natural science and boundless patience when reflecting on any subject Thus, Darwin emerges as Jacques Monod's quintessential man of science--setting up a systematic confrontation between logic and experience

Thomas Huxley's autobiography is even more fragmentary and throws little light on matters such as the "Battle of Oxford" His interests were wide-ranging and by the time he was elected Fellow of the Royal College of Science at the age of 26, his major contributions seem to have been on the structure of the human hair sheath and on the anatomy of the Medusae. His four-year voyage on *H. M. S. Rattlesnake* which was surveying Australian waters was somewhat similar to Darwin's *Beagle* odyssey. Apart from his contributions to science, he is best known for championing the theory of natural selection and defending it from attacks particularly those from the clergy. In his autobiography, he sets out his own contributions, "to promote the increase of natural knowledge and to forward the application of scientific methods of investigation to all the problems of life to the best of my ability". He also advanced the principle of agnosticism putting evidence and reason above belief.

Huxley subordinated his ambition for scientific fame to the popularisation of science, organisation of scientific education and above all to fight any clerical opposition to evolution and science. Thus, although scientifically Huxley may not be ranked with Darwin, he emerges as a man who devoted his energies to the promotion and defence of science and acknowledges this with extraordinary candour and intellectual honesty. In his speech when he was awarded the Darwin Medal, he said that his contributions in science were not upto those of either Alfred Wallace who was awarded the Royal Society's first Darwin Medal or of Sir Joseph Hooker, a subsequent recipient. So, why was he selected for this honour? Huxley himself provided the answer: may be as poet John Milton wrote, "They also serve who only stand and wait" but in his case this standing and waiting acquired a peculiar character, that of active defence against the onslaughts on evolution , and science. "I was convinced that the 'Origin of Species' was a ship laden with cargo of rich value, and which, if she were permitted to pursue her course would reach a veritable scientific Golconda "

Autobiographical accounts even if peppered with inadvertent fiction are always worth more than the critical biographies for the reason that, it is expected that the authors would have a greater feel than anyone else for their own material and contributions To that extent, even though the two autobiographies are short, they are worthwhile for the look-in they provide into the minds of two eminent and dauntless Victorians.

N. K. Notani

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Result Fresh-breath confidence, protection against decay strong healthy teeth
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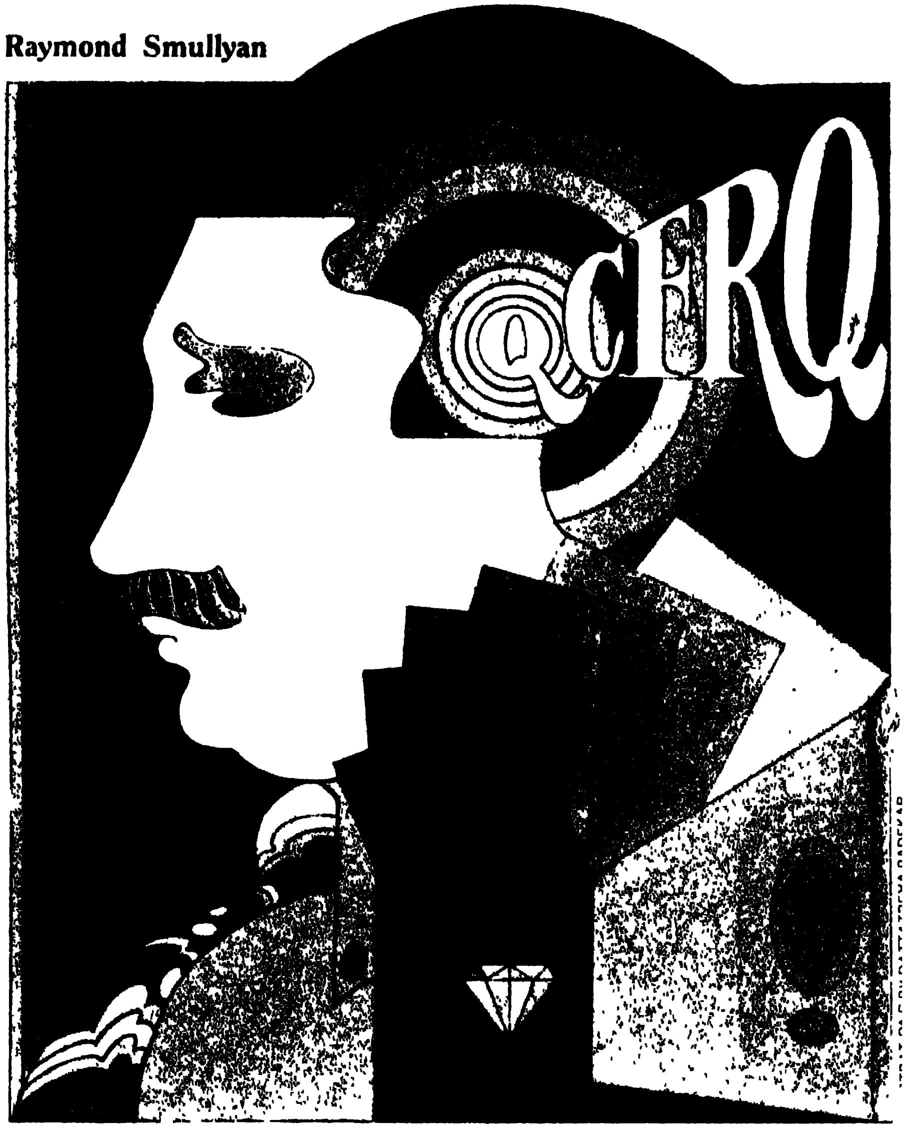
The mystery of the Monte Carlo lock

Raymond Smullyan



WE last left Inspector Craig seated comfortably aboard a train outward bound from Transylvania, relieved at the thought of returning home. "Enough of these vampires!" he said to himself. "I'll be glad to get back to London, where things are normal!"

Little did Craig realise that another adventure awaited him before his return—an adventure of a very different nature from the two already related, and one that should appeal to those who enjoy combinatorial puzzles. This is what happened:

The inspector decided to stop off in Paris to attend to a few matters, and when he had finished he took a train from Paris to Calais, planning to cross the Channel to Dover. But, just as he got off at Calais, he was met by a French police officer who handed him a wire from Monte Carlo, begging him to come at once to help solve an "important problem".

"Oh heavens," thought Craig, "I'll never get home at this rate!"

Still, duty was duty, and so Craig completely changed his plans, went to Monte Carlo, and was met at the station by an official named Martinez, who promptly took him to one of the banks.

"The problem is this," explained Martinez. "We have lost the combination to our biggest safe and to blow it open would be prohibitively expensive!"

"How ever did *that* happen?" asked Craig.

"The combination is written on only one card, and one of the employees carelessly left it inside the safe when he locked it!"

"Good heavens!" exclaimed Craig. "No one remembers the combination?"

"Absolutely no one," sighed Martinez. "And the worst of it is that if the wrong combination is used, the lock will be jammed permanently. Then there will be no recourse left but to blow open the safe, which, as I said, just isn't feasible—not only because of the cost of the mechanism but also because some extremely valuable and highly fragile materials are stored in it."

"Now, just a minute!" said Craig, "how can it be that you use a lock mechanism that can be permanently damaged by a wrong combination?"

"I was very much against purchasing the lock," said Martinez, "but I was overruled by the board of directors. They claimed that the mechanism had some uniquely valuable features which more than compensated for the disadvantage of possibly ruining it by using the wrong combination."

"This is really the most ridiculous situation I've ever heard!" said Craig.

"I heartily agree!" cried Martinez. "But what is to be *done*?"

"Frankly, I can't think of anything," replied Craig, "and *I* certainly cannot be of any help, since there are no clues I'm very much afraid I have made this trip for nothing!"

"Ah, but there are clues!" said Martinez, a little more brightly. "Otherwise I would never have put you to the trouble of coming here."

"Oh?" said Craig.

"Yes," said Martinez. "Some time ago we had a very interesting though rather queer employee, a mathematician particularly interested in combinatorial puzzles. He took a keen interest in combination locks and studied the mechanism of this safe with great care. He pronounced it the most

"Of course it is," replied McCulloch. "My machine is not a random device! It operates according to strictly deterministic laws.

unusual and clever locking mechanism he had ever seen. He was constantly inventing puzzles, with which he amused many of us, and once he wrote a paper listing several properties of the locking mechanism, and asserting that from these properties we could actually *deduce* a combination that would open the safe. He gave this to us as a recreational puzzle, but it was far too difficult."

"And where is this paper?" asked Craig. "I suppose it is also locked up in the safe with the card bearing the combination?"

"Happily, no," said Martinez, as he produced the manuscript from his desk drawer. "Fortunately, I kept it in here."

Inspector Craig studied the manuscript carefully.

"I can see why none of you solved the puzzle; it appears extremely difficult! Wouldn't it be easier simply to contact the author? Surely he remembers or could reconstruct the combination, couldn't he?"

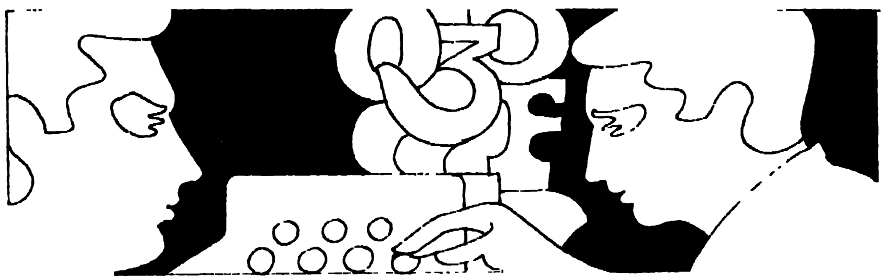
"He worked here under the name of '*Martin Farkus*', but that was probably an assumed name," replied Martinez. "No efforts to find him have been successful."

"Hm!" replied Craig, "I guess the only alternative is to try and solve this puzzle, but it might take weeks or several months."

"There is one more thing I must tell you," said Martinez. "It is absolutely imperative that the safe be opened by June first; it contains some state documents that *have* to be produced on the morning of June second. If we cannot find the combination by then, we will be forced to blow open the safe regardless of cost. The document itself won't be hurt by the explosion, since it is in a very stout inner safe, as far as possible from the door of the outer safe. And as for the other items—well, this document comes first! But it would be worth quite a sum of money to us not to have to resort to that alternative!"

"I'll see what I can do," said Craig, rising. "I can't promise you anything, though of course I'll do my best."

After Craig's return to London, he at first spent a good deal of time on the Monte Carlo lock puzzle. Then, since he was getting nowhere, he decided that it might be best to rest a while from the problem and went to visit an old friend named Norman McCulloch whom he had not seen for years. He and McCulloch had been fellow students at Oxford, and Craig recalled him in those days as a delightful, if somewhat eccentric, chap who was constantly inventing all sorts of curious gadgets. Now, this whole story takes place in the days before modern computers were invented, but McCulloch had put together a crude mechanical computer of a sort.



"I've been having ever so much fun with this device," explained McCulloch. "I've not yet found any practical use for it, but it has some intriguing features."

"What does it do?" asked Craig.

"Well," replied McCulloch, "you put a number into the machine, and after a while a number comes out of the machine."

"The same number or a different one?" asked Craig.

"That depends on what number you put in."

"I see," replied Craig.

"Now," continued McCulloch, "the machine doesn't accept *all* numbers - only some. Those which the machine accepts, I call *acceptable* numbers."

"That sounds like perfectly logical terminology," said Craig, "but I would like to know which numbers are acceptable and which are not. Is there a definite law concerning this? Also, is there a definite law concerning what number comes out once you have decided what acceptable number to put in?"

"No," replied McCulloch, "*deciding* to put the number in is not enough; you have actually to put the number in."

"Oh, well, of course!" said Craig. "I meant to ask whether once the number has been put in, if it is definitely determined what number comes out."

"Of course it is," replied McCulloch. "My machine is not a random device! It operates according to strictly deterministic laws.

"Let me explain the rules," he continued. "To begin with, by a *number* I mean a positive whole number; my present machine doesn't handle negative numbers or fractions. A number N is written in the usual way as a string of the digits 0,1,2,3,4,5,6,7,8,9. However, the only numbers my machine handles are those in which 0 does not occur; for example, numbers like 23 or 5492, but not numbers like 502 or 3250607. Given two numbers *N*, *M*—now by NM I *don't* mean N times M! By NM I mean the number obtained by first writing the digits of N in the order in which they occur, and then following it by the digits of M. so, for example, if N is the number 53 and M is the number 728 by NM I mean the number 53728. Or if N is 4 and M is 39, by NM I mean 439."

"What a curious operation on numbers!" exclaimed Craig in surprise.

"I know," replied McCulloch, "but this is the operation the machine understands best. Anyway, let me explain to you the rules of operation. I say that a number X *produces* a number Y, meaning that X is acceptable and that when X is put into the machine, Y is the number that comes out. The first rule is as follows:

"*Rule 1:* For any number X, the number 2X (that is, 2 *followed* by X,

"Machine needs a little oiling,' commented McCulloch

not 2 times X!) is acceptable, and 2X produces X.

"For example, 253 produces 53; 27482 produces 7482, 23985 produces 3985, and so forth. In other words, if I put a number 2X into the machine, the machine erases the 2 at the beginning and what is left - the X—comes out."

"That's easy enough to understand," replied Craig "What are the other rules?"

"There is only one more rule," replied McCulloch, "but first let me tell you this. For any number X, the number X2X plays a particularly prominent role. I call the number X2X the *associate* of the number X. So, for example, the associate of 7 is 727; the associate of 594 is 5942594. Now, here is the other rule:

"*Rule 2*: For any numbers X and Y, if X produces Y, then 3X produces the associate of Y.

"For example, 27 produces 7, by Rule 1; therefore 327 produces the associate of 7, which is 727. Thus 327 produces 727 Again, 2586 produces 586, hence 32586 produces the associate of 586, which is 5862586."

At this point, McCulloch fed the number 32586 into the machine and, after much groaning and squeaking, the number 5862586 finally did come out.

"Machine needs a little oiling," commented McCulloch "But let's consider another example or two to see if you have fully grasped the rules Suppose I put in 3327, what will come out? We already know that 327 produces 727, so 3327 produces the associate of 727, which is 7272727 What number does 33327 produce? Well, since 3327 produces 7272727 (as we have just just seen), then 33327 produces the associate of 7272727 which is 727272727272727 As another example, 259 produces 59, 3259 produces 59259, 33259 produces 592592259259, 333259 produces:

5925925925925925925925 9259 "

"I see said Craig, "but the only numbers you have mentioned so far which seem to produce anything are numbers beginning with either 2 or 3 What about numbers beginning, say, with 4?"

"Oh, the only numbers accepted by this machine are those beginning with 2 or 3, and not even all of those are acceptable. I am planning one day to build a larger machine which accepts more numbers."

"What numbers beginning with 2 or 3 are not acceptable?" asked Craig

"Well, 2 alone is not acceptable, since it does not come within the scope of either Rule 1 or Rule 2, but any multidigital number beginning with 2 is acceptable. No number consisting entirely of 3s is acceptable. Also 32 is not acceptable, nor is 332, nor any string of 3s followed by 2 But for any number X, 2X is acceptable; 32X is acceptable, 332X and 3332X are acceptable; and so forth In short, the only acceptable numbers are 2X, 32X, 332X, 3332X, and any string of 3s followed by 2X. And 2X produces X; 32X produces the associate of X, 332X produces the associate of the associate of X-- which it is convenient to call the *double associate* of X, 3332X produces the associate of the associate of the associate of X—this number I call the *triple associate* of X—and so on "

"I fully understand," said Craig, "and now I would like to know just what are the curious features of this machine to which you have alluded?"

"Oh,' replied McCulloch, "it leads to all sorts of curious combinatorial puzzles---here, let me show you some!"

1.

"To begin with a simple example," said McCulloch, "there is a number N which produces itself; when you put N into the machine, out comes the very same number N. Can you find such a number?"

2.

"Very good," said McCulloch, after Craig showed him his solution. "And now for another interesting feature of this machine: There is a number, N which produces its own associate—in other words, if you put N into the machine, the number N2N comes out Can you find such a number?"

Craig found this puzzle more difficult, but he managed to solve it. Can you?

3.

"Excellent!" said McCulloch. "But there is one thing I would like to know how did you go about finding this number? Was it just trial and error, or did you have some systematic plan? Also, is the number you found the only number that produces its own associate, or are there others?"

Craig then explained his method for finding the number N in the last problem, and also answered McCulloch's question as to whether there were other possible solutions. The reader should find Craig's analysis here to be of considerable interest, and it facilitates, moreover, the solutions of several other puzzles of the present chapter.

4.

"Apropos of my last question," said McCulloch, "how did you solve the first problem? Is there more than one number that produces itself?"

Craig's answer is given in the solutions.

Inspector Craig ultimately did succeed in solving the mystery of the Monte Carlo lock

Solutions

1.

One such number is 323. Since 23 produces 3 (by Rule 1), then, by Rule 2, 323 must produce the associate of 3, which is 323—the very same number!

Are there other such numbers? For Craig's answer, see the solution to Problem 4.

2.

The number Craig found was 33233. Now, any number of the form 332X produces the double associate of X, so 33233 produces the double associate of 33—that is, the associate of the associate of 33. Now, the associate of 33 is the original number 33233; hence the double associate of 33 is the associate of 33233. Thus 33233 produces the associate of 33233—that is, it produces its own associate.

How was this number found and is it the only solution? Craig gives his answers to these questions in the solution to the next problem.

3.

Here is how Craig found a solution to Problem 2 and also settled the question of whether or not there are any other solutions. I shall give his explanation in his own words:

"My problem was to find a number N that produces N2N. This N must be one of the forms 2X, 32X, 332X, 3332X, etc, and I must discover X. Could a number of the form 2X work? Clearly not, since 2X produces X, which is obviously shorter (has fewer digits) than the associate of 2X. So no number of the form 2X could possibly work

"What about a number of the form 32X? It also produces a number which is too short; it produces the associate of X, which is obviously shorter than the associate of 32X.

"What about a number of the form 332X? Well, it produces the double associate of X, which is X2X2X2X, whereas what is required is to produce the associate of 332X, which is 332X2332X. Now, can X2X2X2X be the same number as 332X2332X? What about the comparative lengths? Well, letting h be the number of digits in X, the number X2X2X2X has $4h + 3$ digits (since there are four Xs and three 2s), whereas 332X2332X has $2h + 7$ digits. Can $4h + 3 = 2h + 7$? Yes, if $h = 2$, but for no other h. So lengthwise, a number of the form 332X may be possibility, but only if h has two digits.

"Are there any other possibilities? What about a number of the form 3332X? It produces the triple associate of X, which is X2X2X2X2X2X2X2X, whereas what is required is to produce the associate of 3332X, which is 3332X23332X. Could these numbers be the same? Again, letting h be the length of X, the number X2X2X2X2X2X2X2X has $8h + 7$ digits, whereas 3332X23332X has $2h + 9$ digits. The only solution to the question $8h + 7 = 2h + 9$ is that $h = 1/3$, so there is no whole number h that will make $8h + 7 = 7h + 9$; therefore no number of the form 3332X can work

"What about a number of the form 33332X? It produces the quadruple associate of X, which has a length of $16h + 15$, whereas the associate of X has a length of $2h + 11$. Of course, for any positive integer h, $16h + 15$ is larger than $2h + 11$, so a number of the form 33332X produces something too large

"If we take a number beginning with five 3s instead of four, the disparity between the lengths of the number it is supposed to produce and the number it actually produces is even greater, and if we take a number beginning with six or more 3s, the disparity is greater yet. Therefore, we are back to 332X as the only possible solution to the problem, so X must be a two-digit number Thus, the desired N must be of the form 332ab, where a and b are single digits to be determined. Now, 332ab produces the double associate of ab, which is ab2ab2ab2ab. It is *desired* that 332ab produces the associate of 332ab, which is 332ab2332ab. Can these two numbers be the same? Let us compare them digit by digit:

ab2ab2ab2ab
332*ab*2332*ab*

"Comparing the first digits of each number, we see that a must be 3. Comparing the second digits, b must also be 3 So N = 33233 is a solution, and is the only possible solution."

4.

"To tell you the truth," said Craig, "I solved the first problem by intuition; I didn't find the number 323 by any systematic method. Also, I have not yet considered whether there is any other number that produces itself.

"But I don't think this should be too difficult to settle. Let's see now, could a number of the form 332X work? It would produce the double associate of X, which is X2X2X2X, which has a length of $4h + 3$, with h being the length of X. But what is required is to produce 332X, which has a length of $h + 3$. Obviously, $4h + 3$ is greater than $h + 3$, if h, is a positive number, so 332X produces a number that is too large. What about 3332X or some number beginning with four or more 3s? No, the disparity would be greater yet, the only possibility is a number of the form 32X (a number of the form 2X is clearly no good; it can't produce 2X, since it produces X). Now, 32X produces X2X, and what is required is that it produce itself, which is 32X So 32X must be the same as X2X Letting h be the length of X, 32X has a length of $h+2$ and X2X has a length of $2h+1$ So $2h + 1 = h + 2$; this means that h must be 1. So X is a single digit Now, for what digit a is it the case that a2a = 32a? Obviously, a must be 3 Hence 323 is the only solution"

Inspector Craig ultimately did succeed in solving the mystery of the Monte Carlo lock That he could do so was a tribute not only to his own ingenuity and that of McCulloch but also to the remarkable logical and mathematical puzzles around which McCulloch had built his crude mechanical computer

Excerpted from The Lady or the Tiger? and other logical puzzles by Raymond Smullyan published by Penguin Books 1983 UK price £2.50 (Distributed in India by Penguin Overseas Ltd)

Raymond Smullyan received his M.S. at the University of Chicago and his Ph.D. at Princeton University, and is currently on the faculty of Lehman College, New York In addition to being a Professor of Mathematical Logic he has performed as a professional magician

ELECTRONIC DICE

THE device described below uses two integrated circuits, ten transistors, ten LEDs and other discrete components. You can use the device to play a dice game. Every time you press the pushbutton the device will light up one of the ten LEDs representing a particular number. The circuit operates so fast that nobody can predict which LED will light. Try your luck.

For ease of understanding, the entire circuit of the device can be subdivided into four stages, the first stage being an astable multivibrator using IC 555 operating at about 1 kHz.

The IC 555 used as an astable multivibrator has its trigger terminal connected directly to the threshold terminal 6. Thus, to start with, there is no charge over the 0.1 mfd timing capacitor. This triggers the lower comparator which, through the control flip flop and inverting amplifier, drives the output high and simultaneously makes the discharging transistor Q14 non-conductive. This causes the capacitor to charge through the 1K and 4.7K resistors. This charges the timing capacitor to ⅔rd Vcc level, that is, threshold level of the upper comparator. This re-sets the flip-flop, which in turn drives the output to its normal low state and brings the discharging transistor Q14 back to conduction. As the terminal No. 7 of the IC is now clamped to ground through the discharging transistor, the timing capacitor, instead of charging, starts discharging through the 4.7K resistor. When the voltage across the capacitor falls to ⅓rd Vcc level, the lower comparator gets triggered and once again changes the states of the output and discharging transistor. This causes the capacitor to charge again. This completes one cycle of operation and initiates the next. The process continues, making about 1000 cycles per second.

The IC 4017 is a CMOS type of decade counter-divider. The IC 4017 contains five flip-flop stages, plus a few logic gates. The IC is basically used as a decade counter-divider with 10 decoded decimal outpouts for input pulses 0 to 9.

When you press the pushbutton the decade counter IC counts the number of pulses provided by the preceding astable multivibrator. When the pushbutton is released, the counter continues counting, for a second or two. This delay is purposely provided by using the RC delay circuit in the "clock inhibit" terminal of the IC. When the delay is over, the counter stops counting and the last LED which was lit when the delay was over remains lighted.

When the counter counts, you will feel as if all the ten LEDs are lit. Actually the astable multivibrator operating at 1 kHz makes each LED light successively for about a millisecond. The speed being very high for our eyes to perceive you will feel as if all the ten LEDs are lit.

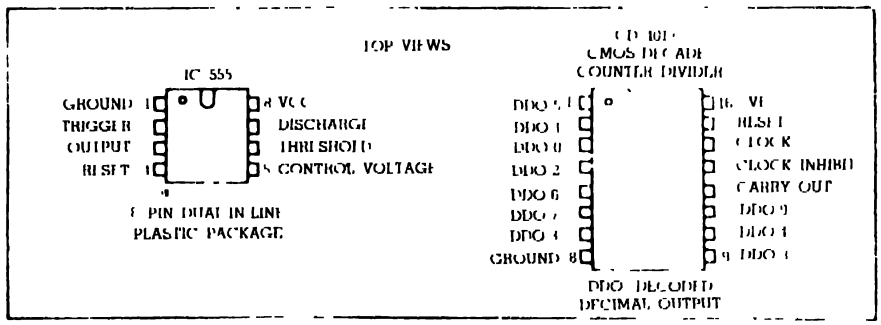
The CMOS decade counter/divider IC 4017 by itself is unable to handle current required to lit the LEDs. Thus, ten transistors are used to operate ten LEDs. The IC drives the transistors and the transistors drive the LEDs. This LED driving circuit forms the third stage of the device.

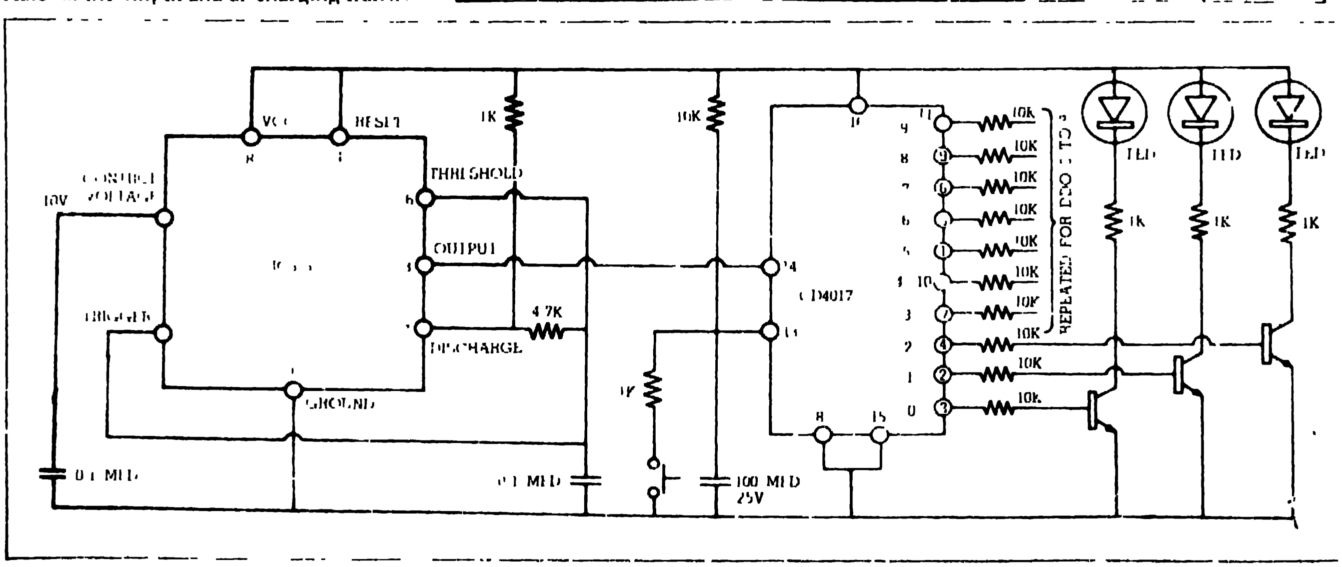
For simplicity, the circuit shows only three transistors driving three LEDs. The LEDs represent decoded decimal outputs (DDO), 0, 1 and 2. Remaining seven transistors and LEDs 3 to 9 are not shown. You will have to repeat the circuit for DDO 3 to 9.

The fourth and the last stage is the power supply. Simple full wave rectification using a bridge rectifier with adequate filter capacitor provides about 15V DC supply.

You will need:

Semi conductors: Integrated circuits 555—1 no., 4017—1 no., transistors BC107

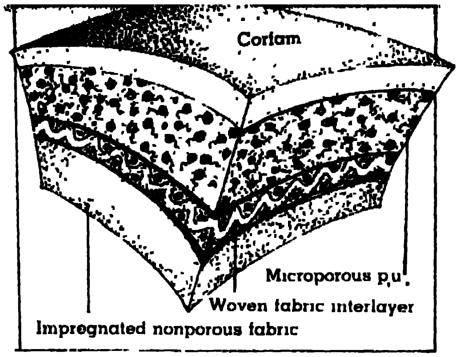




Continued from page 28

The poromeric uppers are more durable than leather uppers. But the very durability brought in the problem of odour. Leather shoes will be discarded when they have lost their looks which is probably long before hygienic problems arise. Sanitation of component materials is something to be looked into in poromeric shoes which are long lasting.

For wear performance in terms of customers' maintenance, poromerics have obvious attraction as a damp cloth wiping for instant cleaning is a material virtue. The leather has a permanent deformation (adjusting to the shape of the foot) to a much greater extent than poromerics—a most important property for comfort during wear.



The anatomy of artificial leather (Corfam)

Scuffing is usually worse on leather shoes. But in poromeric shoes, the scuffing occurs generally on the inside quarter near the heel, where it is not very much noticeable in wear.

Poromerics are usually less affected by sweat than some leathers. But similar degradation has recently been observed in shoes with poromeric uppers.

From the point of view of styling, poromerics have both advantages and disadvantages when compared to leather. Although the range of colour and finishes of poromerics is wide, it is not as wide as in leather. But poromerics can be cut with greater economy. Poromerics can also provide answer to the problem of caring for light colours, as most of them are easy to clean, and mud and other marks can be washed off without damaging the appearance of the material. However, poromerics lack the natural beauty of leather which can be merchandised as a symbol of genuineness and credibility. Poromerics offer no threat to leathers since they lack the characteristic patterns and texture of the grain. Poromerics simply lack the aesthetic and "natural" appeal. □

K. A. Ramasamy and Dr K. S. Jayaraman are scientists at the Central Leather Research Institute, Madras. Dr N. Ramanathan is the Director

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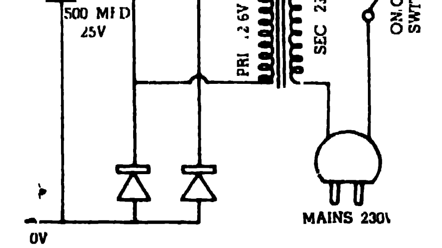
equivalent 10 nos.; LED—10 nos., BY 125 or IN4002- 4 nos

Capacitors Electrolytic 500 mfd—25V—1 no , 100 mfd- 25V—1 no.
Ceramic or polyester, 0 1 mfd—2 nos

Resistors all ½ Watt type; 10K -11 nos . 4.7K—1 no., 1K—12 nos

Approximate cost of above electronic components in Bombay market is Rs. 125.



Transformer Pri 230V AC Sec 12.6V at 250 mA

Misc: IC experimenter's veroboard, push button, on/off switch, fuse 500 mA with holder, suitable enclosure, solder, wires, screws, etc

Anil V. Borkar

Digital and linear circuits

DIGITAL integrated circuit can probably be best explained by contrasting digital circuits with linear circuits. In a linear circuit a continuous variable input signal gives rise to a continuously variable output in a desired manner, which is related to the input variable by some mathematical expression. In a digital circuit the input and output signals are assigned only two values: a so-called logic zero or low state, which is practically zero volt and a so-called logic one or high state, which is often some defined positive voltage. The output of a digital circuit element can, in general, assume only one of these two levels in response to an input or inputs also having one of these two levels. The performance of a digital circuit for voltages in between these two levels is generally not required and thus not defined. Digital integrated circuits are used in, to name a few examples, digital watches, clocks, TV games, calculators and computers.

The common types of digital integrated circuit are RTL (resistor-transistor logic), DTL (diode-transistor logic), TTL (transistor-transistor logic), ECL (emitter-couple logic) and COSMOS or CMOS (complementary-symmetry metal oxide semiconductor). Each of these types offers its own particular advantages, compared to the other types, but all except CMOS, have the following common disadvantages: (1) high quiescent current, (2) regulated power supply requirement, (3) low input impedance of the order of a few hundred ohms and (4) poor noise immunity.

The CMOS digital integrated circuits, on the other hand, have the following unique properties: (1) negligible quiescent current, (2) can be operated from a wide range of supply voltage; regulated power supply not necessary; (3) exceptionally high input impedance of the order of a million megohms (one megohm is equal to 1,000,000 ohms), (4) high noise immunity, (5) output can virtually swing from zero to full positive voltage.

Injectable contraceptives:

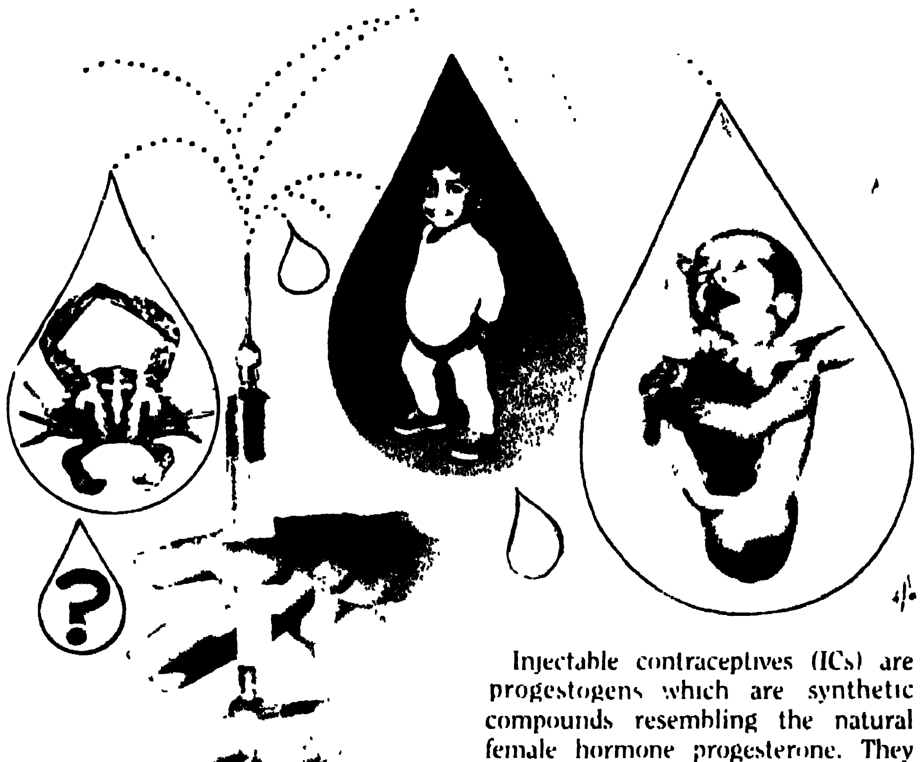
Soon an injectable contraceptive may be introduced in the Indian family planning programme. But what are its effects on the health of the women and their children? A discussion follows with stress on social and ethical issues

IT IS now well known that an injectable contraceptive has been on trial in this country and that it may soon be introduced in the Indian family planning programme. It is equally well known that a controversy surrounds the use of the injectables, with two sharply opposing camps, one vehemently 'for' and the other equally vehemently 'against' the introduction of the injectable. Since a decision on the injectable will affect millions of women in India, several groups are deeply concerned over the implications of the government's policy regarding injectables. It is, therefore, relevant for the public at large to be aware of the issues surrounding the injectables' controversy.

In March 1982, soon after the news about 'successful' trials of an injectable contraceptive was announced by the Indian Council of Medical Research (ICMR), the Centre for Education and Documentation (CED) in Bombay published a 15-page booklet titled *Injectables: Immaculate Contraception?* The booklet has summed up the issues for the lay public. One pertinent point raised in the CED booklet is the injectable currently on trial in India is norethisterone enanthate (Net-En) manufactured by the West German firm, Schering, and not enough is known about this particular drug. It is not an injectable which is widely used in the world as yet and there is very little available information about its short-term and long term side-effects and safety.

The world wide controversy has mainly surrounded the use of medroxy progesterone acetate or Depo Provera (DP) by Upjohn, an injectable used on about 10 million women in 80 countries over the past 15 years. Since injectable contraceptives have some general principles in common, it is relevant to examine the controversy over DP, elements of which are equally applicable to other injectables. This relates not only to the scientific criteria but also the factor of 'social control' which is a key issue in the injectables controversy, as important in significance as the doubts about the side-effects and safety.

Let's have a look at some basic facts about DP and Net-En, culled from the CED booklet. It is an extremely well-researched report whose scientific facts have been taken from impeccable sources like the George Washington University's *Population Reports*, WHO publications like *World Health*, and other respected academic journals covering population issues.



Injectable contraceptives (ICs) are progestogens which are synthetic compounds resembling the natural female hormone progesterone. They prevent pregnancy in four ways: by inhibiting ovulation, by changing the texture of the cervical mucous so as to form a barrier to the invading sperms, by making the endometrium (lining of the uterus) less suitable for the implantation of a fertilised ovum and by decreasing the rate of transport of the ovum through the fallopian tubes to the uterus. DP resembles progesterone and acts more by preventing ovulation, while Norigest (brand name of Net-En) acts by thickening the cervical mucous and is structurally similar to testosterone (a hormone secreted by the testis).

DP accounts for 98 per cent of the ICs used in the world, both in the western countries like France, Sweden, West Germany and Norway and the developing countries like Thailand, Bangladesh, Africa and Latin America. DP has not been officially sanctioned in India, but it has been used off and on by private family-planning workers in different parts of the country. Net-En, however, has been on trial and ICMR deputy director general, Dr B. N. Saxena, has claimed that after testing on

The issues at stake

Vimal Balasubrahmanyan

2,600 women at 14 research centres no 'serious' side-effects have been reported. When CED investigators approached the Institute for Research in Reproduction in Bombay, an ICMR unit involved in the ongoing trials, for more facts on Net-En, they were told that no information could be released. The example of DP is, however, sufficiently relevant to the Indian situation because of the possibility of the government soon giving the green signal to the injectable form of contraception.

Why an injectable?

The first question is: why an injectable? ICs are claimed to be as effective as the pill in preventing pregnancy. A single injection confers contraceptive effect for three months. It is easy and quick to administer. It cannot be 'forgotten' by the woman like the pill. In the eyes of policy makers it thus has an attractive 'cost-benefit ratio' for use in a mass programme. It is also claimed that the side-effects of oestrogen, an ingredient of the oral pill, are avoided by using the injectable There is a catch in this in actual practice In many instances, oral oestrogen is given routinely to DP acceptors as adjunct therapy for the heavy bleeding which is a frequent side-effect of the injectable

DP has a range of disagreeable side-effects: menstrual chaos which begins with initial, heavy bleeding followed by absence of periods; intermittent and unpredictable bleeding ranging from spotting to heavy blood loss, weight gain, hair loss, diminished libido, depression and headaches All these are side-effects which cause much distress, discomfort and inconvenience to women, besides being unacceptable in certain socio-cultural milieus with taboos associated with menstruation. These side-effects are termed by the supporters of the injectable as "not serious" and "not harmful" This attitude overlooks the fact that these side-effects provide strong motivation for discontinuation by users as well as drop-outs from mass programmes.

Long-term safety of DP is a subject of controversy mainly in the matter of interpretation of research studies. Studies on beagle dogs have shown the development of breast tumours and experiments with rhesus monkeys have shown the development of endometrial cancer. Opponents of the injectable say that both findings are cause for concern which constitute a strong argument *against* the use of the injectable. Proponents of the injectable say that the particular animal studies were 'inappropriate' and that the findings are not applicable to human beings No adequate long-term studies have been done on women who have received the injectable over a period of time. Such studies would be difficult to carry out because the countries where it is in mass use are also the countries where long-term monitoring of acceptors would be difficult, given the prevailing inadequate health-care network, typical of developing nations. Some studies of women on the injectable, report a higher incidence of cervical cancer but this again is disputed by the two sides

Another possible consequence of DP-use is infertility which also has been inadequately researched. Several reports mention a delayed return to fertility after discontinuation while there are some suggestions of possible permanent infertility Because of the uncertainty, WHO recommends that DP should only be used by women who have completed their families.

The risk of foetal abnormality has also not been completely researched. This risk exists when pregnant women receive the injection– a very distinct possibility when the ICs are used in mass programmes with insufficient screening of potential acceptors. Also, while DP does not seem to depress lactation like the oral pill, it is secreted in breast milk and the effect on breast-fed infants has not been adequately monitored. Some effects may surface only during the puberty stage of the child, as has happened during diethylstiboestrol administration (a nonsteroid oestrogen used therapeutically as a substitute for natural oestrogenic hormones) which used to be given to pregnant women to prevent threatened abortion. It was subsequently found to cause vaginal cancer in exposed babies many years later after they had grown up.

WHO has said that the effects of ICs on the later development of infants exposed in utero are *not* known. It has also said that the research should go on regarding the metabolic effects and physiological consequences of long-term use of injectables on carbohydrate and lipid metabolism. According to a report by Stephen Minkin (formerly of UNICEF), who has been a vocal opponent of DP, the immune responses are affected with DP use thus increasing vulnerability to infection This is a serious contraindication for use on malnourished women in countries where the health care system is grossly inadequate. His stand is based on an interpretation of the monkey studies which have shown DP to be an 'immunosuppressive' drug, which results in 'lowered host resistance to infection'

However, both the WHO and the International Planned Parenthood Federation are *in favour* of using the injectable for contraception, especially, in developing countries on the grounds that its benefits outweigh its health risks. The risks of the injectable are seen by its supporters to be less in magnitude than the risks of repeated pregnancies which have resulted in the prevailing high maternal mortality rate. It is argued that other contraceptives like the pill and the IUDs (intrauterine devices) also have side-effects and that the injectables are 'the best of the bad lot'

Controversy over the use of injectables has taken a piquant turn with the furore in UK and USA this year, regarding the licensing of DP in these countries for wide contraceptive use In UK, DP is licensed only for limited short-term use by women whose partners have had a vasectomy and are waiting for the sperm count to drop; and by women who have received rubella vaccine against German measles and need effective contraception for the period when the vaccine is potent. However, since last year, supporters of DP (which includes the Medical establishment of UK) have been urging the Health ministry to license the drug for long-

term contraceptive use So far the UK Health ministry has *not* allowed long-term use even though its own Committee for Safety of Medicines has recommended that it should be allowed for use by those for whom all other forms of contraception have been unsuitable and for those who are 'incapable' of using other forms of contraception. Interestingly, the UK Health Minister last year ruled that the risks outweigh the benefits

In the USA, the Food and Drug Administration (FDA) is reviewing its earlier refusal to license DP for contraceptive use DP, however, is used for treating certain gynaecological disorders and other medical problems, including abnormalities in physical growth and development, and various types of malignancies such as cancer of the uterus, breast, kidney, testis and bone Thus the drug is not banned as such, and there is no provision for preventing its use for contraception. Similarly, though not licensed for contraception in the UK, doctors are free to prescribe it at their own discretion In both countries there have been umpteen reports of the 'selective' and 'racist' use of DP on women of the low socio-economic group, without their full awareness of the risks and frequently without their informed consent

Pressures build up

The pressures on the FDA to officially license DP for contraception comes mainly from (apart from the manufacturers, Upjohn) the various population control aid agencies, including USAID, which are at present inhibited by the FDA stand when they try to promote the drug in the Third World The US law prohibits export of products not licensed for use at home Further, there is natural hesitation among some (not all) of the Third World governments to allow the use of a drug not acceptable in terms of safety in the rich nations Among opponents of the injectables are Ralph Nader's Health Research Group and feminist and health activists the world over

Opposition to injectables has two aspects, the uncomfortable side effects

and long-term safety constitute the health aspect The other is the potential for misuse of the injectables because of the social control wielded by those who administer it. For example, it is feared in the West that if it is licensed for long-term use it will be used mainly on the poor, the disadvantaged, the blacks and the ill-informed, and when thus used the safety aspect and the side-effects may not be adequately explained to them.

In the Third World the majority of women belong to the category of poor and disadvantaged and thus what is seen as the racist and selective use of the injectable in the rich nations, becomes in the developing world a major onslaught on large numbers of women This has indeed been the case in Thailand There are reports that at refugee camps in Cambodia, women were offered chickens and other inducements to accept the injectable. In a mass programme, there is potential for indiscriminate use without proper screening and without the informed consent of 'acceptors' in the frenzy to meet 'targets' and fulfil 'quotas'. This issue of social control in which the women may become victims, is what most worries the opponents of the injectable in the Third World.

Minkin and other critics in the West have alleged that scientific studies are being manipulated to yield 'favourable' results and that most of the studies are being done by the supporters of the drug and are therefore biased. They have also alleged that the findings of past studies are not made freely available and that 'undesirable' findings are being suppressed so that the injectables can get a green signal for mass use in the Third World.

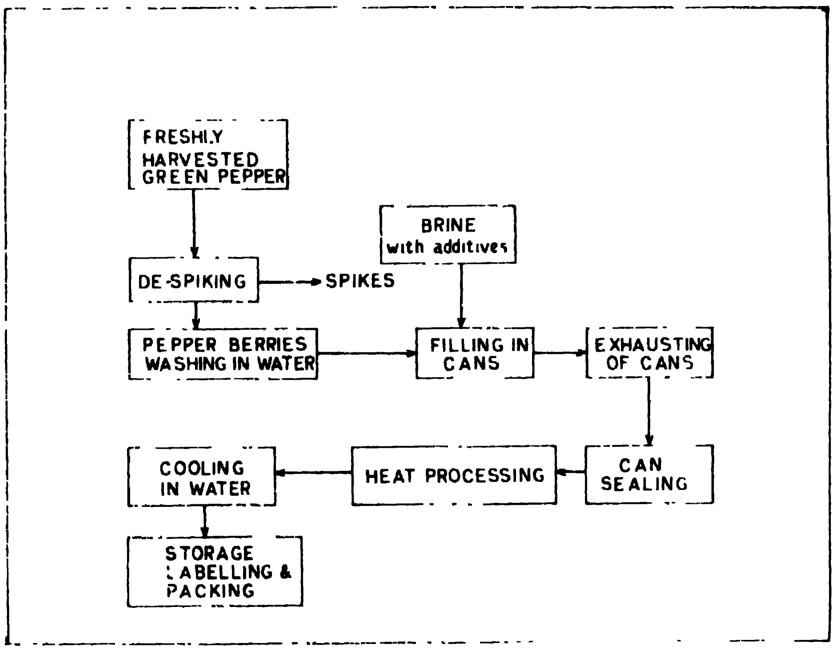
And finally, abuse of the injectable is of particular concern in countries like India where injections are widely equated with 'good medicine'. It has been argued that women themselves want and ask for the injectable and that many are prepared to suffer both the side-effects as well as the long-term cancer risks because they desperately want contraception. There is a difference, however, between women making a truly informed choice with full knowledge of risks and women asking for and getting an injection without being told about all the aspects.

The 'Campaign against Depo Provera' in UK has documented hundreds of examples from all over the world about the injectable being foisted on the unsuspecting Stephen Minkin has documented the fact that the manufacturers Upjohn have themselves admitted to paying large amounts as bribes to the hospital employees and government agencies in various countries so as to increase sales of the drug. The admission was made at an official Congressional deposition.

Thus it is seen in the controversy over injectables that the scientific norms on safety are inextricably linked with issues of social and economic concern In India, the feminist and health groups are anxious that the public should be fully aware of all the issues surrounding injectables If the government decides to introduce the injectable in its official family planning programme, an informed public will be better armed to prevent abuse and avoid the tragic happenings which have occurred in less vigilant countries. It is also the objective of the opponents of the injectable to create a public demand for research into safer, acceptable forms of contraception which carry no health risk and which have no inherent potential for abuse.

Ms Balasubrahmanyan is a free-lance journalist writing chiefly on socio-medical and feminist issues

Improved green pepper canning

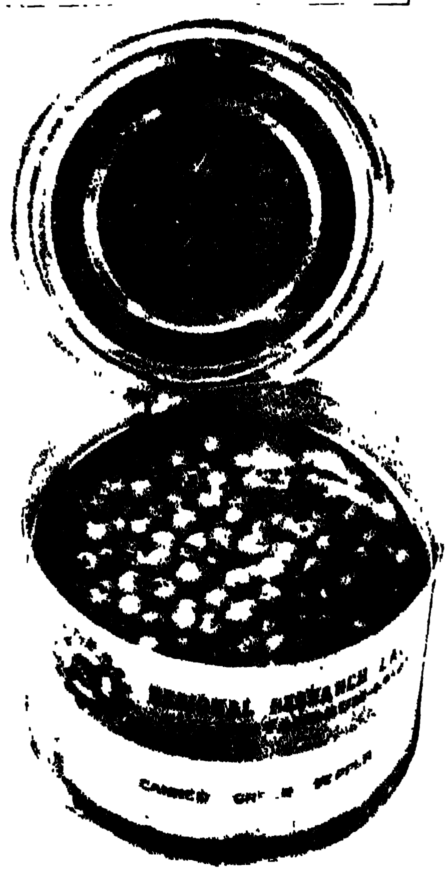


Flow diagram for production of canned green pepper

A TEAM of scientists led by M Gopalakrishnan at the Regional Research Laboratory at Trivandrum has developed an improved process for canning of green pepper Earlier attempts had failed due to discolouration of covering liquid, rupturing of berries gelation and sedimentation The new process overcomes these problems and maintains the freshness and characteristic taste of green pepper

The process involves selection of pepper at a slightly immature stage which is despiked and steeped in chlorine water for 30 minutes Then the berries are washed thoroughly filled in cans of required sizes to the appropriate levels The cans are finally filled with brine containing the permissible additives exhausted sealed and processed for required duration

The problem of discolouration has been solved by suitably adjusting the pH (hydrogen ion activity) of the covering liquid The rupturing of berries gelation and sedimentation of starch is prevented by adjusting the heat processing The proper texture, pungency and flavour of pepper is maintained by selecting it when it is at optimum maturity



Philippine solar collector

A LOW-COST, simple to operate, highly efficient, parabolic cylindrical solar concentrator has been designed by Mr. J. G. Real of the College of Engineering and Agroindustrial Technology of the Philippines

The solar concentrator focusses solar radiation to heat energy collecting materials, like copper, steel and bronze tubes of high thermal conductivity and produces energy in large quantities for boiling water and heating fluids. By adjusting the flow rates of these fluids, different working temperatures can be obtained. It is claimed that the device boils water in 2½ minutes.

At the centre of the tube, the temperature can go up to 160°C; this can be increased if the tube is coated with black sooting material. Without this black coating, the efficiency of the collector is an estimated 21 per cent.

The device has three main components: a wooden mould frame, parabolically cut and joined together to serve as the skeleton of the concentrator, the reflecting sheet, made of a rectangular GI sheet covered with a plastic-aluminium foil, and a water film sealed in between to provide a sharp focus, and the copper collecting tube of 1 cm diameter and 91 44 cm length, rigidly held in the line of focus.

The solar collector, which can be assembled in 30 minutes, costs about $7.

Spotting the tippling motorist

RESEARCHERS in West Germany have developed a cheap and portable alcohol analyser called Alcomat which determines the concentration of alcohol in the breath within a few seconds. The unit can be operated on a 12 volt automobile battery (mobile) or a 220 volt system (stationary). The analyser is easy to operate and shows the exact result as a digital figure and documents the values measured Faulty measurements caused by hasty or interrupted breathing and by residual alcohol in the mouth are eliminated.

The measuring method is based on the principle of infra-red absorption. It makes use of the close relationship between the concentration of alcohol in the breath and in the blood. Ethyl alcohol is known to have

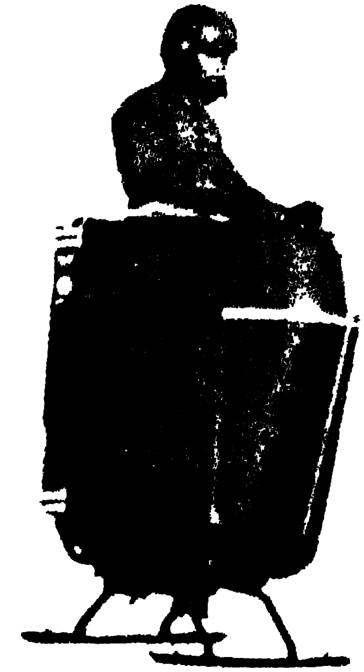
the property of absorbing infra-red radiation particularly heavily at a wave length of 3.4 microns. This produces an electric signal which corresponds to concentration of alcohol.

Before and during each measurement, a microprocessor in the analyser monitors all functions of importance thus excluding operating errors. In a breath test, the correct rendering of a breath sample is also continually monitored, and there is a check to see whether the air is exhaled deep from the lungs. The result of the analysis is digitally displayed immediately after the sample has been rendered, and is printed out as a measuring report giving the date and time. Another important feature of the Alcomat is the fact that the quality of the analyses made in the police patrol car is the same as those produced at the police station. This is achieved by compact design and battery operation

The use of the Alcomat will considerably help to improve police-motorist relations. Both now see an "incorruptible, highly precise" reading. The police no longer has a "margin of discretion" as with the test filters, where it was only possible to analyse a rather indistinct colour line As this method of testing is known to produce relatively big mistakes, while a measurement using the Alcomat is much more accurate, the number of alcohol suspects will in future be much smaller than in the past. Many innocent motorists, all too quickly suspected up to now, need no longer undergo a blood test.

The cost per test will be considerably reduced, being determined mainly by the mouthpiece alone.

Innocent motorists no longer need undergo a blood test



Turbine-powered individual lift device

WASP II, a turbine-powered, individual lift device which can take off vertically and enable a person to fly for 30 minutes at speeds of 96.5 km/hour, has been developed by a U.S. firm The device has been successfully flown by civilian and military personnel

Wasp II is compact and has no wings or exposed rotors, allowing the operator to reach areas that helicopters and other transport devices cannot reach It can also land on a 3 7 square metre area The small turbofan engine producing thrust in the 272 kg class is mounted in front of the operator and is completely enclosed. During flights, the operator controls the vehicle by leaning in the desired direction The lift devbice will accelerate rapidly, move forward, backward, sideways, hover and rotate on its axis.

Mini-hydroelectric schemes for villages

THE Hydro Systems (Tasmania) Pty (HST) of Australia has developed small hydroelectric schemes suitable for power generation in villages, meant particularly for South-east Asia and other developing countries. The systems generate 50W to 1 MW of electricity, depending on the needs of the particular village.

One of the hydro systems offered is the HST Crossflow turbine which is claimed to produce more kilowatt hours of electricity from a known quantity of water than a conventional Francis turbine, when averaged over a full year. The Crossflow is simple to construct, is self-cleaning and suffers no cavitation It is unaffected by altitude and is highly versatile. The efficiency generally exceeds 76 per cent for the smaller sizes and 80 per cent for the larger diameters.

The HST hydroschemes are claimed to require comparatively little maintenance, use no fossil fuel and have a life of over 40 years.

Elastomer formulation for printer's rollers

ISROTHANE—01, a polyurethane elastomer formulation for printer's rollers has been developed by the Indian Space Research Organisation (ISRO) from Isropol prepolymer, with a hydroxl compound such as castor oil as cross linking agent and trace quantities of organo-tin catalysts Printer's rollers made from Isrothane-01 were tested at the Institute of Printing Technology, Madras, and found to give good covering capacity, withstanding water and kerosene cleaning, they did not absorb oil or printing ink It is dimensionally stable with a tensile strength of 5 0 kg cm elongation of 100 200 per cent and Shore A Hardness 30 5

Mending broken bones

AN external fixation system to hold fractured bones in a reliably rigid position has been developed by an Israeli concern It links various points on the fractured bone to a completely rigid metal bar carried outside the affectd limb The linkages, by pins through the skin can be installed under local anaesthesia and avoid the trauma of more extensive invasive surgery After the pins have been fastened to the bone, all necessary adjustments can be made externally, to achieve optimum alignment By this system, heavy and cumbersome plaster casts, which often cause extensive skin irritations, can be eliminated no small advantage in hot climates

Subba Rao gets Borlaug award

The Borlaug award for 1982 goes to Dr. N. S. Subba Rao, head of the microbiology division of the Indian Agricultural Research Institute, for his contribution to the development of agriculture.

Dr. Subba Rao's work on biological fixation of nitrogen and biofertiliser technology has been recognised the world over. He is also known for fundamental and applied research on soil microbiological problems related to plant growth.

He has played a key role in evolving efficient strains of nodule bacteria (rhizobia) for various leguminous crops and has recently developed a new *Azospirillum* biofertiliser for sorghum and millets.

The Borlaug award, instituted by the Coromandel Fertilisers Ltd, carries a gold medal and Rs 10,000 in cash.

Krishan Lal

Dr Krishan Lal, head of the Materials Characterization Division of the National Physical Laboratory, New Delhi, has been elected a fellow of the Indian National Science Academy. In association with Dr A R Verma, Dr Lal and his group have developed a number of advanced techniques for growing and characterising nearly perfect crystals. Dr Lal has authored more than 50 research papers and has edited a book, *Synthesis, Crystal Growth and Characterization*.

D. V. Rege

Prof D V Rege, who has taken charge as Director of the University Department of Chemical Technology, University of Bombay, brings to his job a varied experience. He did his PhD (Tech) from the University of Bombay where he has been a Professor of Food Technology for about 15 years, specializing in nutrition, edible protein and microbiology. He has guided several students for PhD Tech.

R. A. Mashelkar

Dr R A Mashelkar, head of the Chemical Engineering Division, National Chemical Laboratory (NCL), Pune, has been elected a fellow of the Indian National Science Academy, in recognition of his outstanding contribution to polymer science and engineering, notably in industrial polymer reactor modelling and simulation. The polymer science and engineering activity which Dr Mashelkar has initiated at NCL has led to the establishment of a unique school in this area in the country.

Dr. Tomalla Foundation Award

The Dr Tomalla Foundation in Vaduz, Liechtenstein, has awarded its first prize for outstanding contributions to gravitation and cosmology to Dr S Chandrasekhar, professor of astrophysics at the University of Chicago, and Dr A D Sakharov, member of the Soviet Academy of Sciences.

V. L. Chopra

Prof V L. Chopra of the Indian Agricultural Research Institute, New Delhi, and Secretary-general of the 15th International Genetics Congress, has been elected president of the International Genetics Federation.

This cartoon published in SCIENCE TODAY, January 1983, was selected last year for the International Exhibition of Cartoons at Montreal, Canada. It was done by Mr. Suresh S. Sawant, an artist with the* Indrajal Comics *of the Times of India group. Mr. Sawant is also the creator of the 'Bambaiya' comic strip.

BRAIN TEASER

The colour of the sticker

THERE are four friends A,B,C and D, and 5 stickers, 3 red and 2 yellow. A,B and C are blindfolded and made to stand in a row by D who sticks a sticker each on their backs and hides the remaining 2 stickers. When unfolded, A can see the stickers of B and C, B can see the sticker of C only, whereas C cannot see any. D asks A whether he can guess the colour of the sticker on his back. Even after seeing those of B and C, A replies he cannot. On asking B he gets the same reply. Finally, D asks C whether he can tell the colour of the sticker on his back. C knows it! What is the colour of the sticker on C's back?

Wilfred D'Costa

(Solution next month)

Solution to last month's brain teaser

How many wickets Kapil?

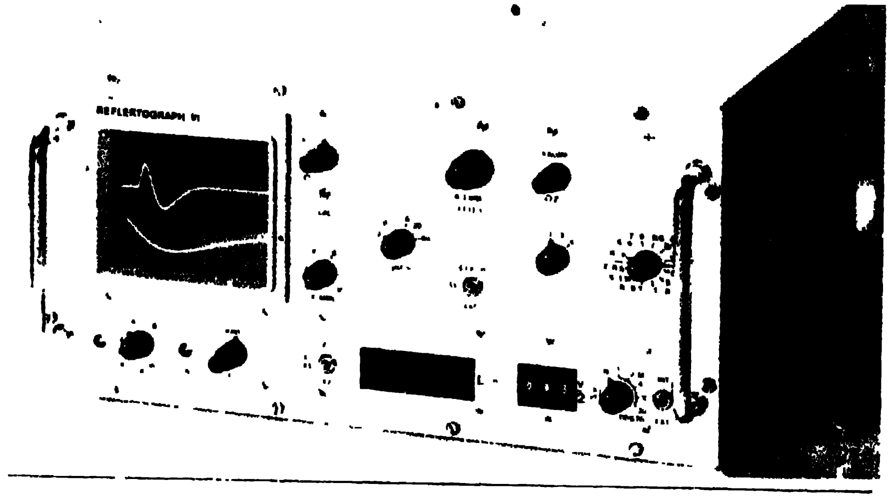
Let x = wickets claimed by Kapil = wickets claimed by Ravi, y = wickets claimed by Madan, z = wickets claimed by Binny.

The solution should satisfy the following conditions, as stated in the teaser. (1) $x > y > z$ or $2x > y + z$, where x and y are perfect squares, (2) x, y and z are greater than 10, (3) $2x + y + z = 100$.

Since x is a perfect square and greater than 10, we have x = 16, 25, 36, 49, 64, 81... and so on. If x = 49, $y + z = 100 - 98 = 2$ which does not satisfy the condition 1. Hence, all values such as 49 and above are ruled out. If x = 16, $y + z = 100 - 32 = 68$. Therefore, $2x < y + z$ which is against condition 1. If x = 25, $y + z = 100-50=50$. Hence, $2x = y + z$ which is also against condition 1. If x = 36, $y + z = 100 - 72 = 28$. So, $2x > y + z$, which satisfies condition 1.

Since y is a perfect square and y and z are greater than 10, y = 16, z = 28−16=12. (If y=25, then z=3, which is less than 10, hence ruled out.)

Hence Kapil, Ravi, Madan and Binny claimed 36,36,16 and 12 wickets respectively.

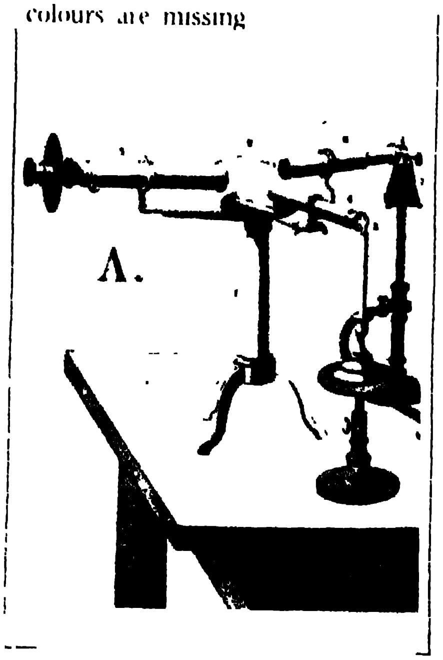


Continued from page 19

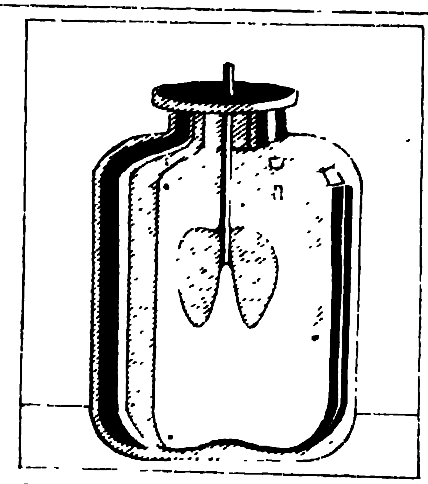
1. Oscilloscope—B: It is essentially a cathode ray tube used to produce a visual image of one or more rapidly varying electrical quantities. It produces a visible pattern, which is the graphical representation of electrical signals by variations of the position of the focussed spot or spots in accordance with these signals

2. Ebullioscope—A: An instrument used to measure precisely the absolute or differential boiling points of solutions. This term is usually applied to an apparatus in which the percentage of alcohol in a mixture is estimated by an observation of the boiling point.

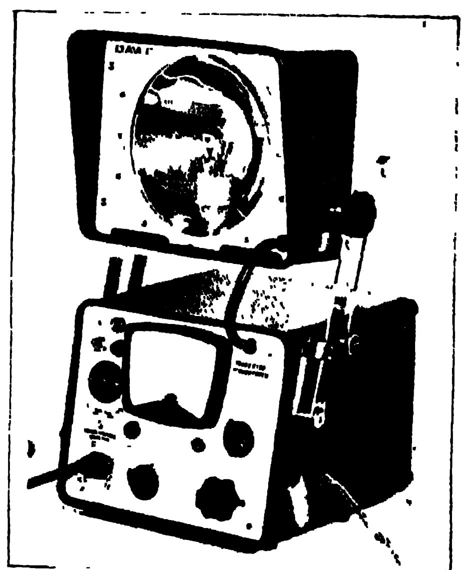
3. Spectroscope—B: A spectroscope is a device for observing the spectrum of colours produced by a prism or a diffraction grating. This is now rarely done except in teaching, but the basic technique has led to a wide variety of devices such as the spectrograph, the spectrometer, the spectrophotometer and the colorimeter In spectroscopes and spectrographs the whole spectrum of light radiation is observed at once by the eye or on a photograph There are both emission and absorption spectra to be studied, emission spectra consist of a series of bright individual colours, while absorption spectra are seen against the complete spectrum of colour and look as if individual colours are missing

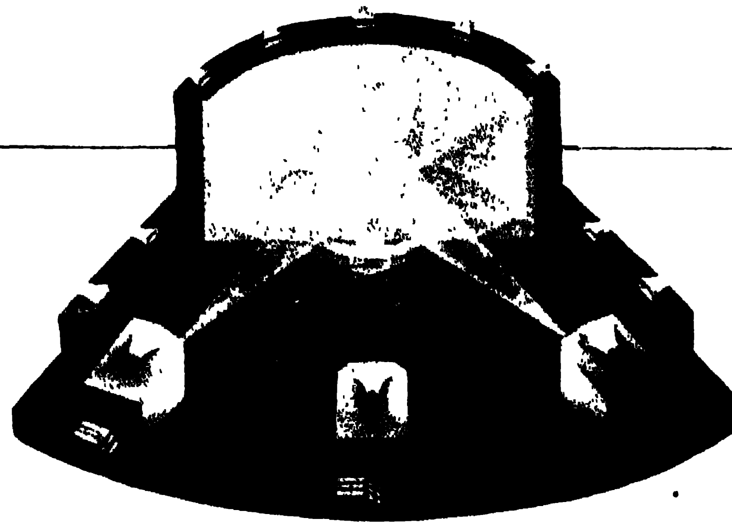


4. Electroscope-C: An instrument for detecting an electric charge by means of the mechanical forces exerted between electrically charged bodies The gold leaf electroscope is one of the most familiar devices used in schools and colleges. Invented in 1787, it consists of two gold leaves on a conducting rod used to detect a charge. On application of body the leaves go apart due to the repulsion between like charges



5. Stroboscope—B: A stroboscope is a lamp which produces flashes of high intensity light at precise, controllable frequencies, and it is primarily used to produce an optical illusion of slowed or stopped motion This illusion is a result of the persistence of vision of the eye, which is its ability to retain an image for a fraction of a second after it has disappeared Stroboscopes have calibrated speed control dials and so the speed of a rotating object can be accurately determined by adjusting the frequency of the stroke until the object appears stationary at which point its speed corresponds to the light frequency shown on the calibrated dial.





6. Cinemascope-A: The key to the Cinemascope wide screen, introduced in 1952, is the costly anamorphic lens. In making the films, this cylindrical lens squeezes the image to half the normal width. This width is more consistent with the eye's normal field of vision than the conventional frame.

7. Koniscope—C: An instrument which indicates the presence of dust particles in the atmosphere

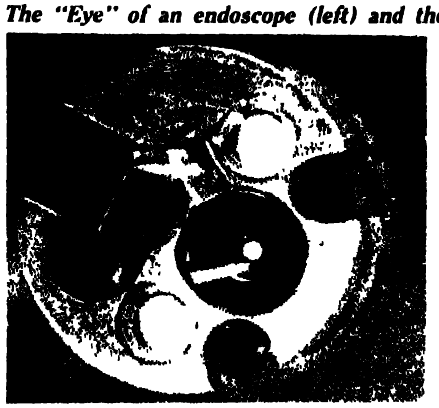
8. Fluoroscope—B: A fluorescent screen designed for use with an X-ray tube to permit direct visual observation of X-ray shadow images of objects interposed between the X-ray tube and the screen Television can also be used to magnify the size of the image which can be viewed on a monitor screen and recorded on film or video tape

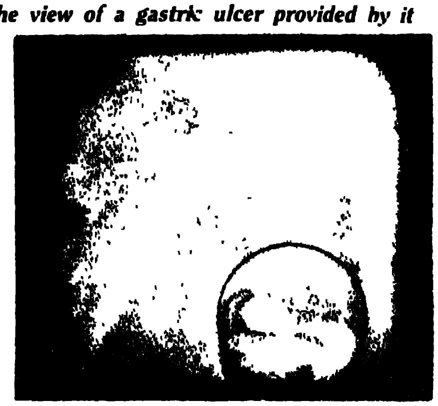
A photograph made from a fluoroscope being examined

9. Aerobioscope—C: An instrument for the determination of bacterial content of air. This can easily be seen from the etymological root of the word which is compounded from aero (air) and bios (life).

10. Laparoscope—A: An instrument used to visualise the abdominal cavity. It is essentially an endoscope with a light source which illuminates the area being investigated. Actually *laparos* in Greek refers to something soft (hence to the flank which is soft and vulnerable).

The "Eye" of an endoscope (left) and the view of a gastric ulcer provided by it





Doublespeak winner

WE did not have as many takers for our December quiz as we had for the November one Perhaps our readers were busy greeting the New Year—1984, the Year of Orwell, which is all the more reason why they should have sent in lots of entries for our competition on *Doublespeak*. Or perhaps it is too much to expect dissimulation in the field of science Nevertheless, the "fork-tongued" Naresh Borkar of Panaji, Goa, had the maximum number (135) of *double entendre* words At the end of the evaluation we were all doubled up—not in agony but in laughter!

Win a prize

FOR this month's quiz, let us evaluate your "scope". Send us as many entries as you can on scopes as the eyes and ears of science Remember to send us brief explanations, too. The closing date for the entries is 5 March 1984 Incidentally, while we *do* wish to thank you for sending us so many entries on meters, we would like you to stick to the stipulated deadline please The entries keep coming in even now.

"SAVE ME PLEASE"

PURSUED by unscrupulous "researchers", hunted by mercenary poachers, the West African chimpanzee is threatened with extinction.

Not that people aren't concerned. The Convention on International Trade in Endangered Species (CITES) has indeed banned trade in wild chimpanzees. But the ban applies only to member nations not all of whom are scrupulous about enforcement. Last November, Japan, a member of CITES, used diplomatic privilege to flout the embargo and smuggle in 30 wild chimps from Sierra Leone. Twenty more of the hapless apes are on their way to Tokyo. When questioned by the CITES Secretariate, Sierra Leone, a non-member nation, which has nevertheless banned the export of the apes since 1978, pleaded diplomatic pressure from Japan which has still to reply.

Why are the chimps so eagerly sought? First the "scientific" reason: this great ape, widely used in medical and psychological tests, can get hepatitis B without falling ill. Hence it has traditionally been used to test hepatitis B vaccines. There are enough chimpanzees in captivity to satisfy the needs of biomedical research but they are expensive. By contrast wild chimps are appallingly cheap. White hunters can buy them in Africa for a paltry ten dollars per head. But it is the method of capture which is truly gruesome: poachers say the only way to catch a chimp is to kill the mother and get the infant. So, for every young chimp caught, one prime adult is butchered.

More tragic is the fate of the enslaved infants. Once exposed, they become carriers of hepatitis and can infect both wild chimpanzees and humans. Moreover, there is no practical method of returning them to the wild.

Earlier, the Austrian Consul in Sierra Leone tried to circumvent the law by offering to set up a hepatitis "research facility" in that African State. He claimed the Austrian Government's support for this dubious deal for which he produced a fellow Austrian animal dealer. The deal was being negotiated for Immuno, the Austrian multinational firm specialising in vaccines and other products from live tissue. Because Austria signed the CITES accord in 1982, the company was no longer free to import wild chimps. And it was unwilling to pay the price of animals bred in US centres (which supply most of the chimps required for research all over the world).

Fortunately, Geza Teleki, Director of Sierra Leone's first national park Outamba Kilimi, advised his Minister of Agriculture and Forestry against the proposal and alerted international opinion. He found there was no way to establish a breeding colony of the magnitude required by Immuno from "just 50 to 60 apes in a couple of years." Indeed, full production for the multinational firm would mean eventual eradication of the total population of 2,000 or so of the wild chimpanzees now in Sierra Leone. The International Primate Protection League and the World Wildlife Fund (WWF) immediately took up the case. And it was found that the Government of Austria did not support the project. But the Austrian animal dealer who holds a monopoly on wildlife trade in Sierra Leone continues to flout the ban and has probably shipped the 50 apes meant for the African "Research Centre" to Japan.

In the ensuing furor, the role of the World Health Organisation (WHO), which is backing the research on the hepatitis B vaccine, is increasingly being questioned. (While Immuno claims WHO support, the New York University's Primate Research Laboratories, which are collaborating with WHO for research on primates have denounced the plan to start an Immuno ape farm in Africa.) The Aga Khan, an influential member of the WWF has already written to the President of Sierra Leone and WHO is under pressure to drop the project. According to a report in the *New Scientist* the Aga Khan has also written to the Director General of WHO about the violation of the Organisation's own guidelines on the exploitation of primates for biomedical research (the policy says rare or endangered animals must not be taken from the wild but from, "existing, self sustaining breeding colonies".)

The crowning irony is that all the slaughter of apes will have been in vain. Thanks to recombinant DNA technology, Biogen, a Swiss-American firm has already developed a vaccine made from the non-infective part of the hepatitis virus. And it is not apes but human beings who will face the vaccine in clinical trials that are slated to begin early this year.

Vithal C. Nadkarni

RANDOM THOUGHTS ON CANCER

I SHALL not be surprised, nay, I am rather anticipating a report which links cancer to the use of a tooth-brush over a prolonged period. While I have neither the intention nor the capacity to question/ridicule the authenticity of the putative report it seems to me that there is a lack of a new sense of direction or thinking, not in terms of cancer therapy, but as regards its very origin.

Mankind has been struggling to free itself from diseases But this battle has always been against foreign or alien invaders about whom we have gained substantial knowledge in the last hundred years. While the struggle continues, when it comes to cancer, it is always against the self and seldom against the invader It will be immediately conceded that, the self is very elusive, most difficult to understand philosophically or otherwise and is often beyond comprehension. Few philosophers claim an understanding of the self, even fewer scientists Indeed, there are none to declare a total comprehension of the self Yet, some of the best minds of science have evolved the concept of self and there are many who are endeavouring to understand the laws of self or the realms of nature

Cancer is often the battle against the self or at least this is the way we have been given to understand it Alternately, can we say that on a grand scale of cosmic time and function, Mother Nature engaged in an experiment which entails the sacrifice of some of its progeny to develop a new entity Or should we say that the self is trying to evolve something which it considers essential to the sustained growth in future (like a tissue to carry out some yet unknown functions of the future) We shall be mistaken to assume that the self or nature can evolve such a system of functions flawlessly or that such an experiment can be restricted to a few human generations. The self will need time And the time-frame required to complete these projections in the future is certainly beyond our conception The self wanted to hear and so it directed a part of itself to differentiate into the auditory system. The self wanted to smell and so it produced by differentiation an olfactory system The self wanted sight and so it developed an opthalmic system The self wanted thought so it developed a tissue which we have just begun to understand in the present century An increase in the cranial cavity volume is one instance. Was it increasing to accommodate a larger-sized brain permitting a large number of functions? We don't know How long did this take and how many mistakes must the self have committed during the differentiation process till a reasonably acceptable organ was perfected? Presumably, each mistake must have caused the premature demise of a large number of the self's children When the self decided to differentiate into a functionally astounding organ such as the liver or kidney, its primordial appearance must have sent death spasms in the then existing body Its development, till it became an acceptable and functional body, must have looked like a cancerous growth.

In its evolutionary efforts the self has to work stealthily as it were against the existing body, for otherwise, the creature will nip the self's experiment in its bud Also the young ones have to be spared the ordeal of the experimentation for obvious reasons Yet the benefit of the experiment has to be transmitted to the next generations

So, perhaps a benign tumour is where the self has opened its laboratory to conduct a large number of experiments to design something for the future. What it is and what it shall become certainly demands an extraordinary mind to visualise In a benign tumour, the self has a laboratory guaranteed to last till the natural forces decide to terminate the very housing or the foundation of the laboratory To extend the analogy further, malignancy is where, the messages or the instructions or the signals have really crossed over resulting in the premature termination of the housing, perhaps much to the chagrin of the self. The self can correct and to some extent it does correct a benign growth but the corrections need exquisite timing So we must look into a benign tumour and ask questions in a manner the self can understand and reply, and then try to comprehend the futuristic experiment of the self Perhaps, this could be the hope on which we can base our understanding of cancer

M. S. Gore

Dr Gore is working in the Biochemistry & Food Technology Division of Bhabha Atomic Research Centre, (BARC) Bombay

Monkey business

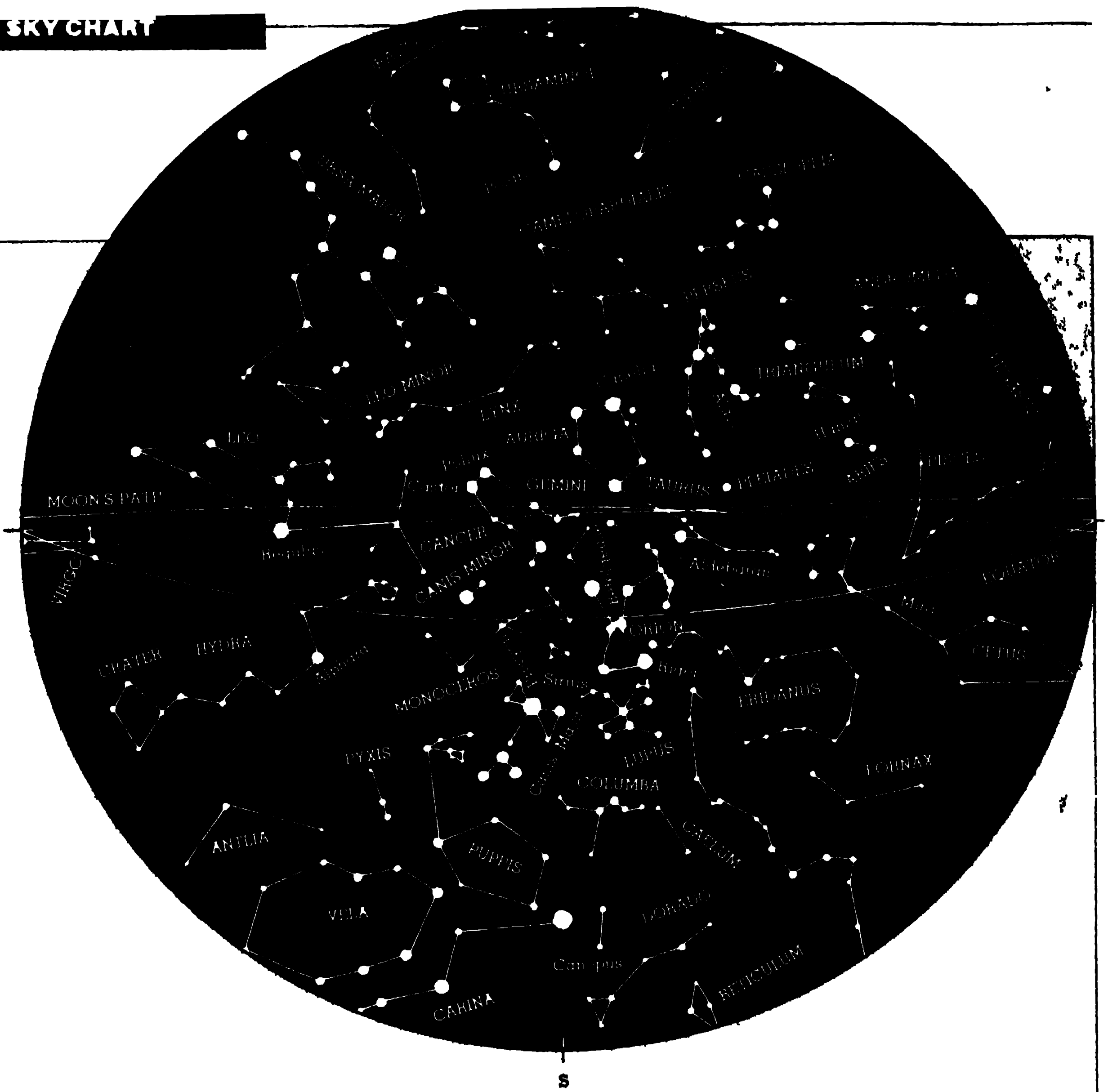
CAN you identify a liar (or a traitor) with a gadget like the lie detector or polygraph? Many people including America's Central Investigation Agency (CIA), seem to think so. The CIA is said to be cajoling the British Government into forcing civil servants with access to top secret material to take polygraph or lie detector tests The CIA's proposal for the pilot scheme on polygraphs came following the conviction of a translator for espionage. He was working at the Government Communications Headquarters (GCHQ) in Cheltenham. The GCHQ liases with America's National Security Agency and CIA.

However, according to experts, despite its "scientific" aura, the scheme is as hare-brained as the medieval witch hunts. An American psychiatrist, Professor David T. Lykken of the University of Minnesota, says there is not a shred of scientific evidence that polygraphs can correctly identify people who are lying about whether they have given away state secrets In the US itself the lie detector test is regarded as a psychological test which "picks out fear rather than deception."

More seriously, Dr. Lykken says polygraphs implicate people for the crimes they did not commit. Three studies in the US found respectively that 39 per cent, 49 per cent and 55 per cent of the people accused of lying were in fact innocent. Dr. Lykken also cited another study at the University of Pennsylvania that found polygraphs to be biased against "highly socialised" or very honest people!

That does not prevent the proliferation of polygraphers. Only a dozen of the 10,000 practising polygraphers are trained psychologists; their only credential is that they have taken a lie detector "course" that lasts from 6 to 12 weeks. And incredible as it may seem, these polygraphers are allowed to judge people with an instrument which has questionable utility

Dr. Lykken was speaking at a conference organised by the Society of Civil and Public Servants. The society is concerned that the scheme will spread to the other parts of the civil service and Dr Lykken says entrepreneurs plan to set polygraph companies in Britain to also screen employees of private companies. □



SKY IN FEBRUARY 1984:
Zodiacal light in the evening sky

Nagpur 21 00h IST
As on 15th February 1984
Magnitude 21° N
Longitude 79°6 E
Sidereal time 6h 25m 44 4s

A strip of zodiacal light will be best seen after an hour and a half past the local sunset over the central latitudes of India. A narrow column of diffuse light will be seen to extend from the west to the zenith. It usually lasts for about half an hour.

Throughout the month, the motion of red-looking Mars past Saturn will be a good thing to watch. Initially Mars will form a triangle with respect to Spica and then it will pass by Saturn on 15th at a very close range. Mercury and Venus will remain in the morning sky, but their altitudes will steadily decline every day. Jupiter will be placed well above Venus. Mercury, Mars, Jupiter and Saturn will appear brighter every day while Venus becomes more dull. There will be occultations of Saturn and Mars by the Moon on 22nd and of Uranus on 24th, but none is going to be visible in India. The Moon will pass by Jupiter and Venus on the 26th and 29th respectively. Up to the end of July, Mars and Saturn will stay almost together and then it will pass by Jupiter and then Venus before it meets the Sun next year.

N. C. RANA

...what makes us feel THIRSTY

WHAT is thirst? What makes you stop drinking after you have had your fill? Is it because you felt full in your stomach? It probably is. But was there enough time for the water to be absorbed from the stomach into the bloodstream before you felt so? Probably not. Then why did you stop drinking?

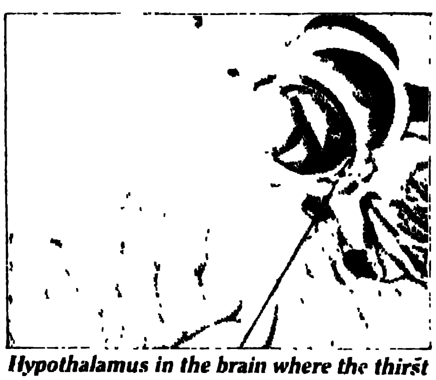
Though we know why water is needed for our survival, what causes thirst is, however, not fully understood. Only in the past 50 years it has been possible to measure changes in the body fluids and investigate how brain influences thirst. Now we know that thirst is controlled by a combination of physiological, behavioural and environmental factors. It is the brain that sums up the situation and the oral sensations such as drying of mouth and throat are merely associated symptoms.

It is found that wetting the mouth and throat is just not sufficient to put an end to thirst. If we prevent water from reaching the stomach by some means, so that whatever is drunk drains out again, thirst is not quenched even if mouth and throat are kept continuously wet. Thirst is, however, satisfied if water reaches the stomach bypassing the mouth and throat. One suicide failure victim had this problem after his attempt to slit his throat failed. His thirst was eased when fluids were fed directly to his stomach.

Thirst can be manipulated by changing the volume or the concentration of solutes in the body fluids. An increase in the concentration of the solutes in the extracellular fluid is found to stimulate thirst. The osmotically active molecules of the solutes in the extracellular fluid, when deprived of water draw it from the inside of the cells, causing cellular dehydration. Specific cells in the brain called osmoreceptors can sense this and trigger thirst. There is now direct evidence about these thirst centres being situated in the brain. From animal studies it is found that when minute quantities of concentrated salt solutions are injected into specific regions in the brain, thirst is stimulated. If instead water is injected, the receptors swell, inhibiting thirst.

Osmoreceptor controlling of thirst is a type of negative feedback mechanism. An increase in the concentration of the solutes in the body fluids stimulates thirst and drinking, dilution quenches thirst. But then there is much more to thirst than this mechanism alone.

The body tries to maintain an adequate volume of blood to ensure that oxygen and nutrients reach the body tissues in required amounts. Hence it is not surprising that changes in the volume of blood can also affect thirst. It is found that a reduction in the effective volume of blood stimulates thirst in animals. This process involves relatively large changes and the effect is not immediate. Receptors that sense changes in



Hypothalamus in the brain where the thirst control centre is located.

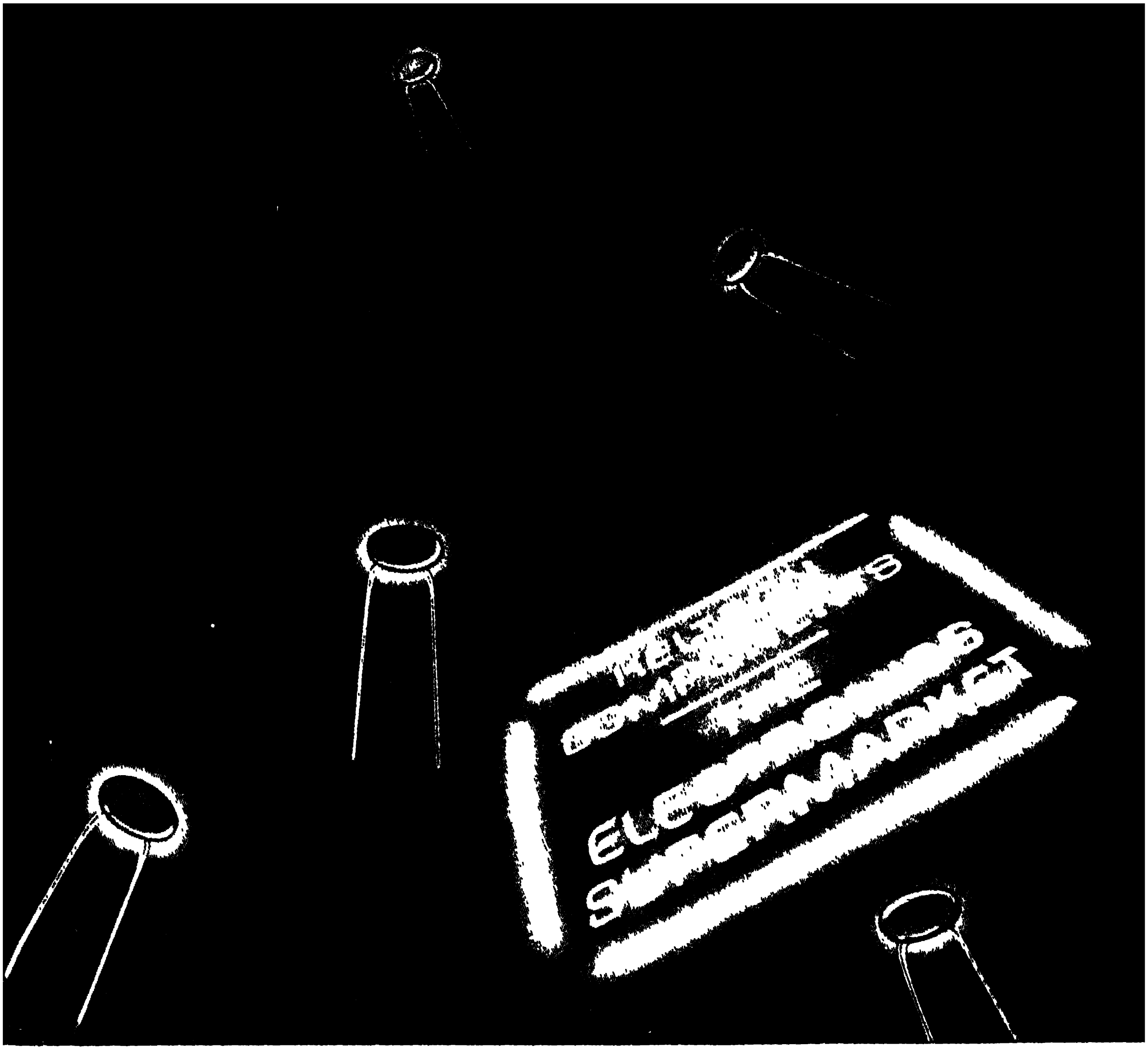
the volume of blood are located on the walls of the heart. When there is an increase in the blood volume, the receptors get stretched and pass on this information to the brain via vagus nerves, inhibiting thirst. This probably explains why astronauts in space drink less. Weightlessness increases the volume of blood in their heart and chest, the stretch receptors sensing this as an increase in the total volume of blood, act to inhibit thirst.

An interesting question regarding thirst is, does the intake of fluids occur in response to the dehydration of the body or do we learn to anticipate such dehydration and drink before deficits occur? Examination of the drinking patterns in several animal species including humans, has shown that differences in the drinking habits exist. Rats, for example, take a large percentage of their water intake just before eating. This is an example of anticipatory drinking. But dogs, seem to drink mainly in response to osmoreceptor dehydration or a decrease in the volume of blood. Studies on humans have shown that they too anticipate deficits in the body fluids before drinking. Their body fluids do not always show changes when they feel thirsty, as compared to when they are not. Surprisingly we humans seem to be better in anticipating thirst than many other species. What then prompts us to drink before dehydration shows up? Oral sensations often associated with thirst could well be the first signal.

Finally what stops us from drinking more? Filling of the stomach could be an important factor. Cold water is found to accelerate gastric emptying in rats, and it is suggested that this might explain its efficiency in quenching thirst. Often we consume drinks such as coffee, tea, etc not because of thirst but for other reasons. As long as our kidneys can take care of the excess water, we can go on having any amount of soft drinks as we like. If the kidneys were to lose control then the thirst mechanism is vital in ensuring that the body maintains its water content and composition.

M. S. Khan

Dr Khan is with the Division of Animal Studies of the Central Arid Zone Research Institute, Jodhpur.



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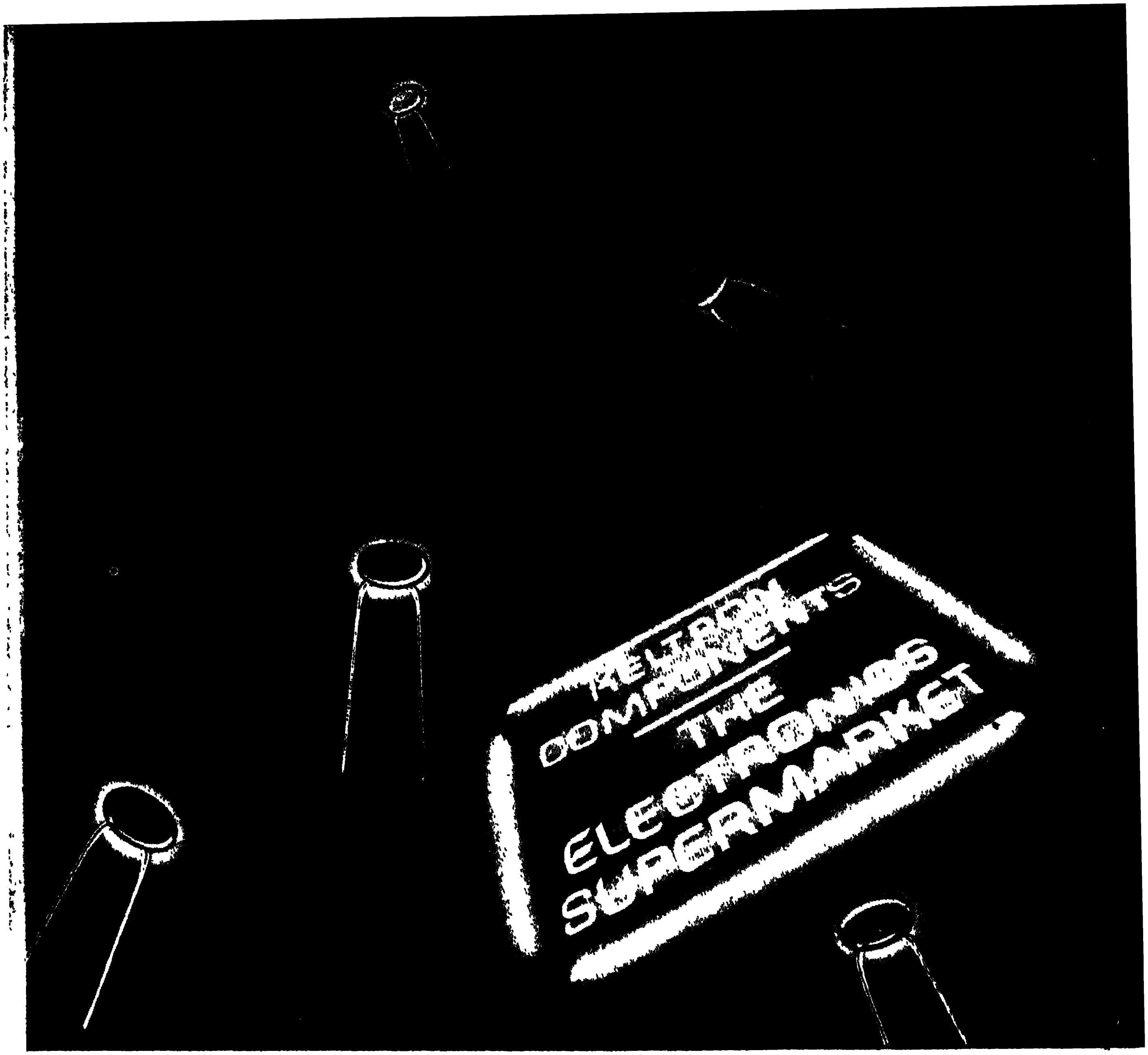
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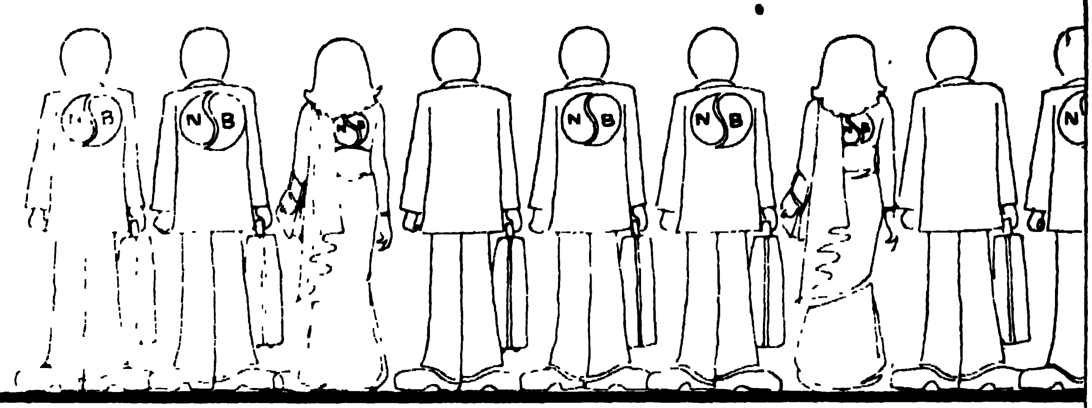

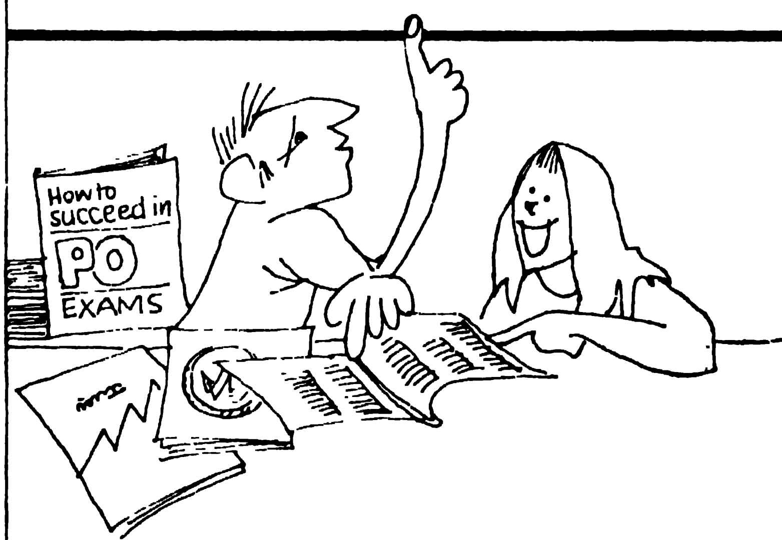
How to
succeed in
PO
EXAMS

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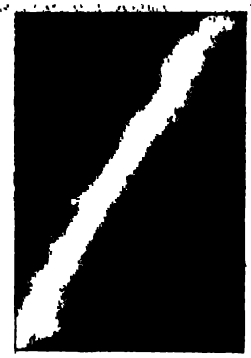

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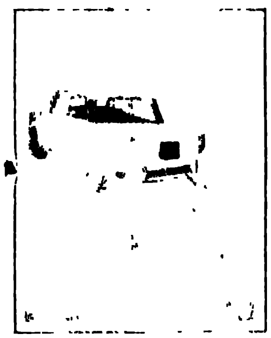

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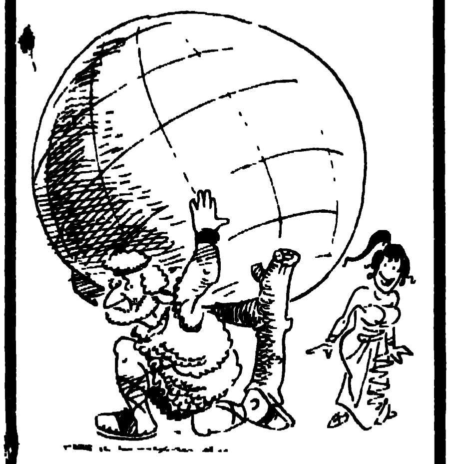
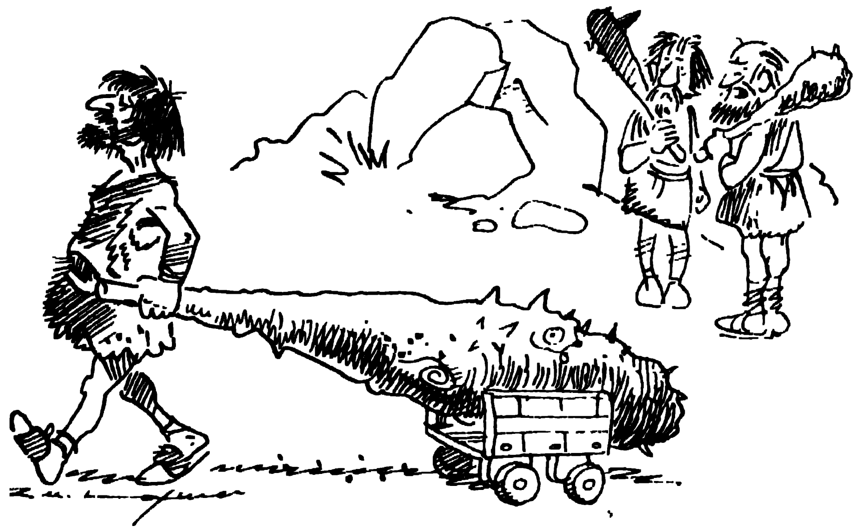
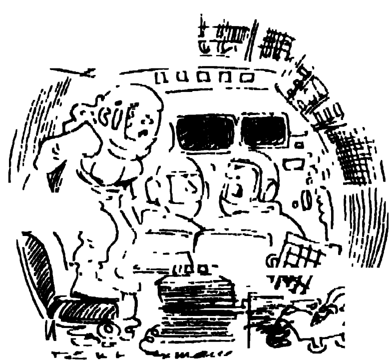
R. K. Laxman



Atlas, you cheat!



Looks formidable, all right! But has he considered its practical applicability in a crisis?



Don't say, Miss, you didn't know we were carrying a few experimental mice on this spaceship?

O.K. you can't find any plumbers. They have all gone to the Gulf. Are you going to wait till they come back one day to fix the washer to the dripping tap?

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SCIENCE TODAY

Vol 18 No 4 April 1984

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***THANKS** to an active media coverage and, in particular, the expanding network of television transmission, an average citizen today is far better informed about the rapid advances being made in the fields of science and technology all over the world. This acquisition of knowledge naturally raises his expectations in terms of material benefits since science is universal and knows no geographical, or other, boundaries. And when these expectations remain unfulfilled he feels let down and blames scientists.*

We feel that there can at best be only partial justification for sustaining this charge against scientists and technologists. Whenever a scientific advance shows some promise it is only an early indication of its future potential. It is just the beginning and to translate that potential into tangible reality one has to progress through several stages. Additional inputs in terms of funds, manpower and equipment have to be provided at each of these stages. Further, every stage has its own share of problems which need to be solved with as much care and accuracy as those encountered in making the original advance itself. The history of scientific development is replete with instances where a highly promising development at the laboratory level floundered at the subsequent stages and had to be abandoned in spite of highly competent scientists and technologists devotedly working on it.

These aspects, however, are not brought home to the common man. The responsibility for this, we feel, lies with the media. Their presentation of scientific progress is not always totally objective and level-headed. At times, it tends to be euphoric, even hysterical, thus misleading the wary reader or viewer into believing that the fruits of these frontier science exploits are his for the picking.

Having apportioned the share of responsibility of the Fourth Estate, we would like to submit that the public as well as policy-makers cannot be absolved of their responsibility, either. There is many an instance where scientists have tried hard to develop a technology to a stage where it can be milked effectively only to helplessly witness later the import of that technology and installation of turn-key projects. More often than not these decisions are influenced by a certain lack of confidence—not always justified—in the ability of our scientific manpower. A more recent case in point is that of the proposed establishment of the Science City. This total trust in the scientists and technologists abroad, albeit Indian in origin, does not help bolster the self-respect, devotion and sincerity of those toiling here. On the contrary, the sceptical and jaundiced view of their competence has a decidedly demoralising effect on our scientists. How can they be expected to succeed and deliver the goods nonetheless?

The constitution of two Scientific Advisory Committees, one consisting of Indian scientists living in North America and the other from Europe, to advise the National Biotechnology Board has also to be reviewed in this context. There's no denying that this is a technology of the future and India should not get left woefully behind when the time comes to harvest it. But would a group of non-resident scientists who have no commitment to our efforts and who cannot appreciate the conditions under which scientists here have to perform really help launch the programme on the road to success? This is not to cast any aspersion on the calibre of these individuals but we strongly feel that there are equally competent scientists here too who additionally have the advantage of knowing the local conditions and hence be in a position to provide much more pragmatic advice.

EDITOR

SIR J. C. BOSE

The articles on Sir J C Bose (November 1983) are all illuminating. I am quoting a portion of a letter by J J. Thomson (the then Cavendish Prof of Physics, at the University of Cambridge, who also later became a Nobel Laureate) to his predecessor, Lord Rayleigh (a Nobel Laureate in Physics): "I have had occasion to read several of Bose's papers and am of the opinion, that he is a very suitable person to receive 'encouragement' if any is going. His experiments are ingenious, and his apparatus very well devised, and it must have required great patience and determination to make the apparatus work in a climate like that of India. The results are very interesting and his paper was received with great applause at Liverpool...."

Bose was then in his late thirties. During that period Bose delivered a lecture at the Royal Institute, London (now Davy-Faraday laboratory). When the lecture was over, Bose was given a tremendous applause, and Lord Kelvin personally approached and congratulated Lady Abala Bose for her husband's brilliant lecture and for the experiments he had demonstrated.

During that European tour in the late nineties of the last century, J. C. Bose also delivered lectures at some of the learned societies in Paris At one such lecture, Swami Vivekananda was present. He was much impressed with the Boses, and wrote in eloquent terms not only about J. C. Bose but also of Lady Bose, because of her great devotion to her husband and to his needs. Through Swami Vivekananda, the Boses had a lasting friendship with Sister Nivedita On reading the book, *Response in Living and Non Living* . she in a letter to poet Tagore made the following remark "The book on *Response in Living and Non-Living* is now triumphant. I want a far greater work, such as only the Indian man of science is capable of writing, on Molecular Physics A book in which that same great Indian mind that surveyed all human knowledge in the era of the *Upanishads* and pronounced it one, shall again survey the vast accumulations of physical phenomena which the 19th century has observed and collected, and demonstrated to the empirical machine-worshipping, gold seeking mind of the west that these also are one---appearing as many"

Another great friend and well-wisher of J. C. Bose was the poet Tagore. When Tagore was awarded the Nobel Prize, Bose wrote him a letter. ' Friend, I am extremely delighted to see you honoured in the eyes of the World" (translation). Bose wrote a book and sent a copy to Tagore with the note, "To the glaring rays of the Sun, I am sending the light of a firefly" (translation). On Bose's 70th birthday celebration, Tagore composed a poem, which concluded with this feeling—"today you are greeted by a thousand lamps—here is a lamp from a friend of yours. You are glorious, and your mother-country has been glorified by you"

Bose was always neatly dressed, calm and to some extent reserved and rarely attended public meetings other than on scientific subjects of his liking. He did not like to move in a crowd. During his walks in the garden or when he was travelling by a car, he was deeply absorbed in thoughts. Probably he felt a kinship with nature and its surroundings. He had a special intuition for recruiting his research collaborators. One such a recruit was Gopal Chandra Bhattacharyya, who did not have any formal University education, but Jagadish Chandra after reading one of his articles, asked him to join his laboratory. Bhattacharyya later made outstanding contributions to entomology.

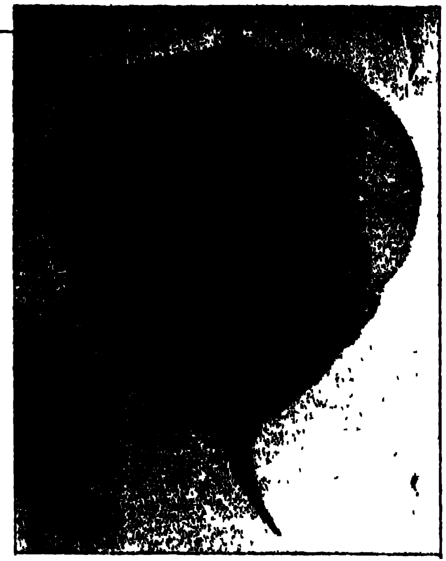
The Bose Research Institute under the stewardship of the present director, Prof. S. C. Bhattacharyya, an eminent Organic Chemist of International repute, has expanded considerably and a new unit has been established at the Salt Lake Area, much to the delight of J. C. Bose's admirers.

Sri Aurobindo Ashram
Pondicherry 605002

N. K. MAITRA

In a recent publication entitled "The Secret Life of Plants", Peter Tompkins and Christopher Bird have given glimpses of startling discoveries about the plant world, bordering on the mysterious In particular, they have given a graphic account of 'The Mystery of Plant and Human Aura'. It has been stated that Semion Davidovich Kirlian, an electrician and amateur photographer and his wife, Valentina, discovered that they could photographically reproduce without lens or camera a strange luminescence which seemed to issue from all living things, but cannot be seen by the human eye.

By laying a film or plate in contact with an object to be photographed and passing through the object an electric current from a high frequency spark generator, which put out 71,000 to 200,000 electrical pulses per second, the Kirlians had come across a way of photographing this 'aura'—or something akin to it. Leaves from plants, sandwiched with the film between the electrodes of their device, revealed a phantasmagoria



A photograph of a leaf taken by Bose, without the action of light

of tiny spots of light.

Kirlian maintained that the strange energy in his pictures was caused by 'changing the non-electrical properties of bodies into electrical properties which are transferred to the film'. Though the initial discovery was made sometime in the 1930s, it attracted the attention of the scientific world in the 1960s. It was brought into the limelight in 1968 by Prof. Vladimir Inyushin, who wrote a book-long scientific paper, "The biological essence of the Kirlian effect" and attributed the effect to bioluminescence. Since then investigations are being increasingly carried out on 'phantom photography' in various countries.

The first observation of such an effect should be associated with J. C. Bose, for he showed the first photograph of a plant leaf without light early in this century. In fact, he published a paper, "On the continuity of effect of light and electric radiation on matter", in the *Proceedings of the Royal Society*, London, in 1901. The behaviour of his self-recovering silver coherer was found to be somewhat analogous to the phenomena of phosphorescence and thermoluminescence The following lines from the book, *The Life and Work of Sir Jagdish C Bose*, by Patrick Geddes (p. 190-207) may be more revealing.

"At this time (1901) Bose was interested in the question of obtaining photographs without the action of light. Various radioactive substances were being found whose emanations affected the photographic plate. But Bose worked with substances which ordinarily were not radioactive. A section of a dried stem of a tree exhibits concentric markings, due to unequal growth in different seasons. These rings, according to Bose (may) emit radioactive particles under the action of (electrical) stimulus. He enclosed a section of stem in a dark box with a photographic plate in front of it, but not in contact. Outside the box were two metallic plates, which were in connection with a micro-wave generator (operated by a

Ford Induction Coil). Under the action of this stimulus, the radioactivity (as he believed) of the wood was evidenced by an extremely clear impression of its structure given on the photographic plate—this, be it remembered, without the intervention of light. The accompanying reproduction (figure) is the photograph of a leaf of Bo-tree taken by the above method. By taking similar photographs, he obtained remarkable results with various stones and crystals, which revealed characteristic differences in their composition. A new field was opened out for immediate exploration, but all this had to be indefinitely postponed on account of another field of inquiry, which demanded his undivided attention".

Would it not then be appropriate to call it "Bose" effect rather than "Kirlian effect"?

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S. D. CHATTERJEE

Human brain gaining weight

Please refer to the item 'Human brain consumes more energy' (Science Shapes Life, October 1983). The news ends with the remark, "one could say that future generations may have more brains than brawn". According to two British neuropathologists, the human brain is getting heavier: "Between 1860 and 1940, the brain weight of men rose from an average of 1,372 to 1,424 grams, while that of women rose from an average of 1,242 to 1,265 grams during the same period; in both cases, the increase is statistically significant in that the weight and volume are found closely related. Further, the size of the human brain and the size of the human skull which encloses it have also both gone up'

No wonder then that the present day children, drawn from any strata of society, appear to be far more intelligent and more curious than the ones born a few decades ago.

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D. VAIDYANATHAN

The Sun also breathes

I read with interest "The Sun also breathes" by Dr. Alurkar (October 1983, p 57). However, Dr. Alurkar does not seem to be correct when he says that the lines due to magnesium-iodide (MgI) and titanium iodide (TiI) are used to derive information about solar oscillations. As far as I am aware the absorption or emission lines due to these molecules have not yet been observed in the solar spectrum. Further the abundance of iodine atoms and the dissociation energies of the two molecules are too low to produce lines of detectable strengths In fact lines due to iodine atoms are yet to be discovered in the solar spectrum.

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K. SINHA

Dr Sinha has rightly pointed out that MgI and TiI should be read as unionised magnesium and titanium and not their iodides I regret misleading them in my article.

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[illegible] and Academies in [illegible] Development

[illegible] in association with the ICSU Committee on Science & Technology for Developing Countries (COSTED), organised a Workshop on the Role of Scientific Societies and Academies in National Development on 15th & 16th November 1983 in New Delhi.

The representatives of the [illegible] Scientific Societies and Academies of Afghanistan, Bangladesh, China, [illegible], Nepal, Pakistan, Singapore, Sri Lanka and Thailand participated in the Workshop. Detailed discussions were held on some of the major problems faced by the countries in this region of Asia. Problems including energy, environment, health care and population control, scientific and technical manpower and training, and resource planning were tackled. The representatives also presented reports highlighting the status of science and technology in their countries, their experiences in tackling these problems as also their thoughts on cooperation on a regional basis. The Indian scientists presented key-papers in each of the five areas and had extensive discussions on how Scientific Societies and Academies can collaborate with each other to work for national and regional development. CONSIDERING the need for Scientific Academies to play a more positive role in national development and RECOGNISING the potential of collective effort in application of science and technology, the delegates RESOLVED—that there is an urgent need for mutual cooperation among various Asian countries in the area of utilising Science and Technology for national development. TO ACHIEVE THIS, it was unanimously agreed that it is desirable to initiate contact with all Academies and Societies in the region with a view to exploring the possibility of the formation of a Federation of Asian Federal [illegible] and Academies. The main activities of such a Federation will be:

(1) To promote exchange of scientific information;
(2) To identify problems of regional interest and determine priorities;
(3) To identify talents, form task forces of individuals or institutions to tackle these problems;
(4) To organise training programmes for man-power development in areas of common interest to participating countries, such as environment, population control, survey and utilisation of natural resources, microprocessors and computers, bio-technology, etc.;
(5) To evolve mechanisms for exchange of scientists to promote research in areas of mutual interest;
(6) To organise joint workshops/seminars/symposia on topics of common interest; and
(7) To prepare status reports and policy options on topics of regional importance with a view to providing scientific information to Governments to enable them to take appropriate decisions.

A. K. BOSE

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Some more on Titanium

The article "The metal with a future" by Dr R. M. Sathe (January 1984) was enlightening. I will like to add the following points:
(i) Vickers hardness of tungsten carbide is 2,100 kg/mm^2 as against the very low reported value of 1,300.
(ii) Vapour phase deposition of titanium carbide is carried out on cutting tools for machining only and not on discs and punches used as wear parts.
(iii) One of the most important uses of this metal is as multiple complex solid solution of (Ti-W-Ta-Nb) carbide in cutting tools, which is instrumental for improvement in productivity, quality and cost reduction. There is a substantial consumption of this material in the country.

SURJIT SINGH

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This has reference to my article 'Titanium - the metal with a future' (January 1984). You have probably, for want of space, omitted the acknowledgement cited at the end of the article. I gratefully acknowledge the help given by Dr. V. M Karve, Manager (Planning & Projects), Indian Rare Earths Ltd, and Dr M. Sankar Das, Head, Analytical Chemistry Division, BARC in the preparation of this article.

R. M. SATHE

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Filariasis leads to sterility

CHANDRAPUR district, in Vidarbha, Maharashtra, is one of the most backward districts in the country. Tribals live in dismal, unsanitary conditions—illiterate, semi-naked, starving, diseased inhabitants form the bulk of the population. Infectious diseases are rampant in the district and those not affected by leprosy, tuberculosis or filariasis feel that something is wrong with them. Utter poverty has seen to it that the majority cannot even travel to Nagpur for free treatment.

A new angle came up recently in Chandrapur, when the doctors from the J.J. Hospital, Bombay, visited the district. Secondary sterility was found to be very common in women and hydrocele (accumulation of fluid in the membranes surrounding the testes) in males. The oft-repeated official claims of the success of the family planning programme in the district were immediately hushed up as it became apparent that filariasis led to sterility and hydrocele.

Filariasis is caused by thread-like worms belonging to the family Onchocercidae. Rural filariasis is on the increase in Indian rural areas, especially where the conditions of humidity and temperature are ideal for the breeding of mosquitoes. The unsanitary conditions associated with inadequate drainage facilities support the spread of insect vectors, and indirectly the disease. Its symptoms vary from an intense itching to severe inflammation of the joints, to the skin losing its elasticity. Filariasis is known to lower the immune response of a patient making the victim vulnerable to several infectious diseases. In Chandrapur district "it has led to a cruel method of limiting families", according to Dr H. M. Joshi, of the J. J. Hospital.

Incidentally, even the doctors attending the camp at Sindhewahi and Chimur had to undergo anti-filarial therapy first, in order to beat the disease

Red-letter day for India

INDIA will take a giant stride in manned space flight when Squadron Leader Rakesh Sharma and two other Soviet cosmonauts will enter space aboard Soyuz T on April 22. The docking of the spacecraft with the space station Salyut-7 which is already in orbit, its delinking and return journey have now been finalised by the Soviet space scientists

Squadron Leader Rakesh Sharma (second from right) and Wing Commander Ravish Malhotra (second from left) with the main crew and back-up crew of the Indo-Soviet space flight

After docking Sq. Ldr. Sharma will enter Salyut-7 where he will spend seven days conducting experiments in biomedicine, material sciences and remote sensing (SCIENCE TODAY, November 1983). The biomedical investigation sponsored by the Institute of Aerospace Medicine in Bangalore, is related to the effects of microgravity environment on humans. Aspects such as cardio-vascular deconditioning, space sickness and disturbance of motor functions will also be investigated.

Wing Commander Ravish Malhotra and two other Russian cosmonauts will make up the stand-by team.

Cancer-causing azothioprine

TIME and again, side-effects of drugs have caused a controversy. Azothioprine, a drug prescribed for kidney transplant patients during the past ten years, may have been responsible for causing skin cancer in them, reports a University study in Australia.

A five-year study of 400 patients by the Department of Surgery, University of Sydney, reveals that azothioprine, an immuno-suppressive drug prevents the body from rejecting the new organ (transplanted kidney). The drug affects the cells in the upper layers of skin (epidermis). It prevents the normal repair of the cells that counteracts damage from sun. Normally, new cells are regenerated; however, the drug prevents this, and the old cells then mutate, causing cancer.

According to Graham Kelly and Ross Sheil who did the study, when the drug was brought into use in Sidney in the early 1970, immunologists had anticipated that one of its side-effects would be cancer. But compared to dialysis which is a very tedious and expensive procedure, this seemed an "insignificant risk". It was therefore suggested that patients on this drug would be monitored thoroughly and as soon as cancer appears, they would be treated.

But what was surprising was the high incidence of skin tumours. These were squamous tumours which mainly arose from the epithelial cells. Researchers suggested that the development of skin cancer in transplant patients has implications in studying the development of other cancers too.

Third World as nuclear dust-bin?

IS nuclear industry in the US on a decline? It seems so, going by the recent reports in the different scientific journals—there has not been a single new order for a nuclear reactor in the US since 1978. Problems facing the industry have been many since its inception, but now they seem to have become intractable. The proponents of the nuclear energy are finding it more and more difficult to convince the [illegible]

[illegible] about the viability, [illegible] and environmental, of [illegible].

[illegible] of the industry [illegible] are the high risks to the [illegible] and personnel involved in its operation (contamination problem), high costs of the nuclear reactors (the costs of building nuclear plants doubled during the 1970s and have further increased by another 80 per cent for plants under construction) and the safe disposal of nuclear wastes The existing strategy of the industry, in order to survive the continuing stagnation, is to service the existing plants or to sell reactors overseas.

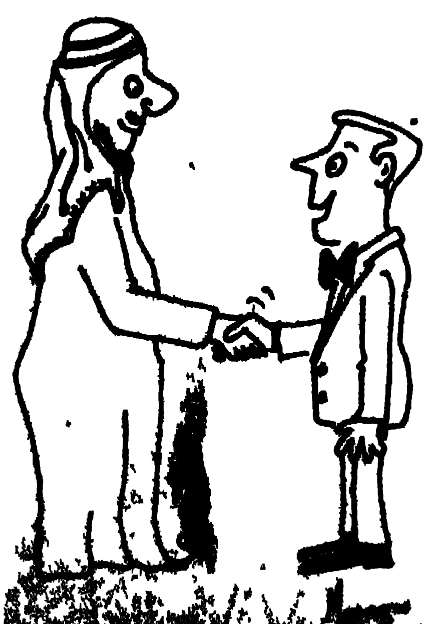
On the question of safe disposal of the nuclear waste, the nuclear industry seems to have reached an impasse Research efforts are continuing to make the 'unsafe' more and more safe, but that not being safe enough, now the approach seems to have changed Some Western countries are thinking of dumping the nuclear waste in the Third World countries, especially in the vast uninhabited tracts of Africa A step in this direction seems to have been taken with China.

China has offered to act as a dust-bin for spent radioactive nuclear fuel from West German reactors A total of 4 000 tonnes of spent fuel, under a long-term contract lasting till the end of this century, is proposed to be stored in the Gobi desert. In return, it will be paid 5.45 billion US dollars. This proposal has yet to meet the approval of the West German Government and US authorisation, especially if spent fuel rods being sent to China, were originally enriched in the US.

China's plan to be a store-house of western nuclear waste will literally make it a plutonium mine, for the latter can be extracted from the nuclear waste Plutonium is the main component of a nuclear bomb.

Of course, China cannot be considered as a true representative of the Third World and its reasons for the import of nuclear waste are entirely different from a situation whereby the African lands may soon be converted into nuclear wastelands

"That's a deal We give you our crude nuclear plants You give us your crude oil."



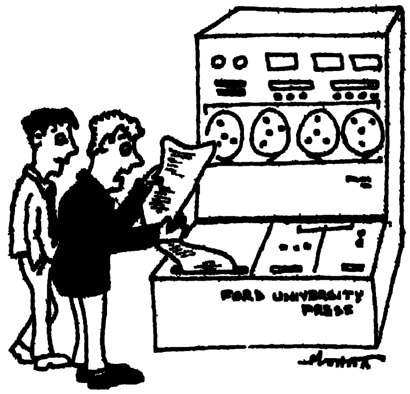
Now you can extract gold more easily

A NEW process for gold extraction has been developed by Norman Haber and John Lee of the US Though chemical and technical details of the process have not yet been disclosed, Haber emphasises that tests on a non-carbonaceous ore assaying at 7.09 gm per tonne indicate that it can be used to recover 95 per cent of the gold in 10 hours at about $2 per tonne The conventional cyanide process by comparison gives a 95 per cent recovery in six days at a cost of $10 per tonne

In the cyanide process, a low grade gold ore is leached in vats, using a solution comprising mainly of sodium cyanide The new hydrometallurgical process is based on a hitherto unknown chemistry for solubilising gold It can be used to recover gold from carbonaceous ores which are very difficult to process with cyanide This process can also be successfully used to extract palladium but not silver

Repository of English to be computerised

AN American firm is going to computerise the entire Oxford English Dictionary (OED) with its 12 volumes, five supplements and a bibliography The computerised OED will be able to cope with the constant language changes more efficiently. Neologisms



"It doesn't explain phrases But here are 24 meanings for 'up' and 36 meanings for 'yours'"

could be logged and substantiated with proper quotes almost instantly, and could easily be issued in monthly instalments

Keeping in mind the need for revision and reprinting, the publishers of OED have also struck a computer typesetting deal which will enable revised dictionary to be brought out within two years.

The target for the first "hard" copy of the new electronic OED is the early nineties It will then be "on-line" to other computers around the world, immediately available to scholars, translators reference libraries and so on The estimated cost to install the necessary equipment for the project in the OED's headquarters in St Giles, Oxford, in the UK, is £4 million

Laser saves sight

FOR years 11 year old Lisa Finch of Worcester in the UK had battled against the odds But now the cheery youngster has been given a will to live For after a revolutionary operation using

Lisa with her best friend

a laser beam, Lisa's sight has begun to improve.

Lisa had trouble with her eyes right from the start. She was born cross-eyed and she had an operation to turn them. This left her short-sighted and she had to wear glasses. When she was four years old, a mystery illness left her totally blind in her left eye. And at ten she was having trouble seeing the blackboard in the school. Lisa was seen by 17 doctors in all, but no one could actually pinpoint the problem. They said she had tunnel vision and that she needed an operation to stitch the retina back in place, as it had detached. They would put a gas bubble in her eye to keep it in place. After the operation Lisa could see only a faint light. She was almost totally blind and the doctors said they couldn't do anything.

A few days later Lisa was back at the hospital—the blood vessels in her eye were broken. The surgeons said that they would like to try using a laser beam to heal the blood vessels and that there was a slim chance that Lisa's sight might be restored. An eight hour operation and a week after, she could see cloudy shapes. The next day she saw bright colours and outlines and by the end of a week 30 per cent of her sight had been restored.

Lisa loves reading and writing and they are her favourite subjects at school. If she uses a magnifying glass or holds a book up close, she can see quite well.

—**Carole Russell**
(Asia Features)

Did plants evolve from photosynthetic bacteria?

A BACTERIUM which probably represents one of the first steps in the evolution of photosynthesis has been discovered by Howard Gest and Jeffery L. Favinger of Indiana University in the US.

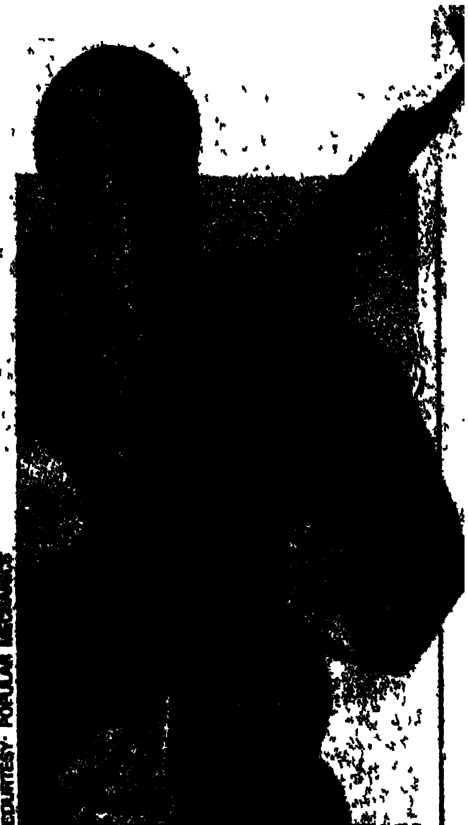
In 1980, Gest proposed a theory, that the pigment or light scattering systems of photosynthetic bacteria evolved independent of the other parts of the photosynthetic machinery. At some point in the remote past when the Earth's atmosphere was still oxygen free, the pigment systems fused with other systems from anaerobic bacteria. Later in evolution, green plants modified the photosynthetic system releasing free oxygen which made higher life forms possible.

The discovery of the *Heliobacterium chlorum* has lent credence to Gest's theory. This green coloured organism contains a unique form of chlorophyll known as bacteriochlorophyll g. It is also supersensitive to oxygen—even minute amounts of air can kill it. Further studies are still to be performed, but early findings seem to indicate that this bacterium may represent one of the earliest steps in the development of photosynthesis.

The peace makers

THIS year's nominations for the Nobel Peace Prize make interesting reading. A group of women who have spent several years camping outside the US Air Force base in Greenhan Common, England, protesting against the deployment of nuclear missiles in the UK, figure prominently on the list. The nomination was submitted by the Swedish Association for Peace and Justice. Interestingly, the two persons, President Ronald Reagan of the US and the British Prime Minister, Margaret Thatcher, against whose decisions these women are protesting, also are among those nominated for the Peace Prize.

Indira Gandhi's name has been put up for her sustained struggle for the Third World and world peace. The other names are those of the Canadian Prime Minister Pierre Trudeau and the jailed South African leader, Neksib Nabdeka.



COURTESY: POPULAR MECHANICS

A soldier wearing the chemical warfare suit

Suit against toxic weapons

CHEMICAL warfare is prohibited by the 1925 Geneva Protocol and the 1972 Biological and Toxic Weapons Convention. However, the superpowers seem to be geared to all possibilities as is evident from a butyl rubber suit and mask reportedly issued to Soviet troops in Afghanistan. According to the US Defence Intelligence Agency, the suit provides excellent protection against "yellow rain" a deadly chemical.

The suit which includes a coat, knee-length boots and gloves is found to be very hot, heavy and difficult to manoeuvre in. A specially treated undergarment should be worn for complete protection against chemical or biological agents.

A filtered canister makes the mask very effective. But the small eyepieces restrict side vision and the lack of voicemitter (device that transmits voice) hinders communication. The suit has other uses too, as a rain coat, field shelter and floatation bag.

Space station in the making

THE National Aeronautics and Space Administration (NASA), of the US, is planning to build a manned space station within a decade. Th

will be used as an orbiting laboratory which will cater to commercial and scientific purposes; as a service station to repair satellites, a building site where astronauts can assemble structures too big to be lofted from the Earth and a space-based launching pad from which manned expeditions could set off for the Moon and Mars.

The space station will be constructed part by part. According to present plans, its vanguard will be put into space by 1992. It will have nearly 200 cubic metres of pressurised space in which a crew of six to eight will live and work. Its core will probably consist of four cylinders, each about 6 metres long and 4 metres wide, that could be carried in successive shuttle launches and assembled in space. Two will be laboratories for life sciences and materials processing, a third will provide living quarters, and the fourth will be a detachable cargo hold. There will also be a docking hub for the shuttle, a power plant fed by half an acre of solar panels and unpressurised platforms to mount sensors and experiments. The cost estimated for the initial station is US $8 billion.

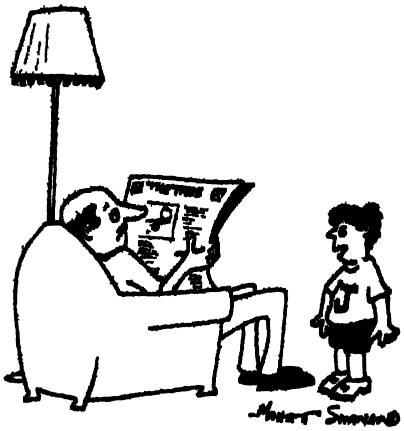
Growing old but not senile

GOODBYE to the notion that old age inevitably entails a steady decline in intellectual capacity. East German research shows that intelligence and mental skills can be increased significantly by training in old age

The Max Planck Institute of Education at Berlin, gave 'intelligence training' to 250 persons aged from 60 to 80. The training programme consisted of five or ten hour-long sessions over two to four weeks with exercises in memory, inductive thought and problem-solving.

To assess the effects of training, the participants were given three-hour intelligence tests before and after a session. There were also follow-up tests after one and six months to discover how long the effects lasted.

Regardless of the participant's initial education, age and sex, the programme produced a clear and lasting improvement in mental performance of those who underwent intelligence training. Paul Baltes, head of the institute, concludes that most ageing people retain either a latent ability or reserves that can be activated for intelligent accomplishments.



"Papa, at your age you must do something to improve your intelligence."

However, he does not deny that physiological deterioration entails a decline in mental abilities in old age. But those elderly people who exercise their minds regularly can maintain peak performance in selected fields, including scientific research. Only a small number of people suffering from definite brain disorders are certain to decline in all respects.

Drugs implicated in causing deaths

DRUGS are meant to give comfort and save lives. But two anti-arthritis and anti-inflammation drugs are strongly implicated in causing more than 10,000 deaths, reports a consumer organisation in the US. The drugs phenylbutazone (Butazolidine) and oxyphenbutazone (Tanderil) manufactured by the Swiss company Ciba-Geigy, are regularly prescribed by Physicians all over the world including India for arthritic problems. According to the Public Citizen Health Research Group, in the US, it is estimated that about 135 million people have already used these drugs. The drugs were held responsible for about 3,100 deaths which occurred in the US and 7,300 deaths in other countries during the past three decades. Hence, the research group has asked the Secretary of Health and Human Services to ban these drugs.

The drugs phenylbutazone and oxyphenbutazone are known to cause aplastic anemia—depression of bone-marrow resulting in reduced production mainly of red blood cells There is also a decrease in the production of white blood cells (agranulocytosis) leading to increased susceptibility to infection. Further, leukemia (blood cancer), gastrointestinal bleeding and peptic (stomach) ulceration, or both, are the other adverse effects caused by these drugs.

In spite of unequivocal evidence, these drugs seem to be bogged down in a controversy. Scientists from Ciba-Geigy insist that phenylbutazone and oxyphenbutazone cause severe reactions including death. However, the management of Ciba-Geigy at New Jersey, disputed the number of deaths occuring due to the consumption of these drugs. The estimate of deaths was 10 times the number known to the company. The Food and Drug Administration is also aware of only 312 deaths though the company acknowledged 1,182 deaths since the introduction of the drugs.

Arthritic drugs are not new to the public. About 50 to 100 million people have been taking phenylbutazone since last 30 years and about 40 to 80 million have used oxyphenbutazone since its introduction in 1961. According to an arthritis specialist at the US National Institute of Health (NIH), "the risks from the two drugs do not appear to increase with extended use, indicating that users who have not had adverse reactions probably will not have them". But then, how does one account for the high death rate with the use of these drugs?

This controversy has caused an inevitable drug scare and the secretary of Health and Human Services has agreed to review the two drugs.

During the years 1981-82, the anti-inflammatory drug, benoxaprofen (Opren), for treating arthritis, caused a commotion in Britain. The drug was said to have a unique mechanism of action and it claimed to prevent arthritis from getting worse. Neither of these claims were substantiated. The range of known adverse reactions extended from mild rashes, bleeding in the stomach and the intestines to fatal bone-marrow damage.

Benoxaprofen was mostly used by patients over 65. Elderly patients with "below par" kidneys take a long time to eliminate the drug. In such cases, the drug concentration in the blood builds up, eventually exceeding the therapeutic level The accumulated drug in the kidney may damage kidney cells and hence it affects the excretion pattern. This may also lead to higher drug levels in the liver, saturating liver enzymes. The liver, thereby, is also less able to metabolise the drug for excretion.

Though this drug is now banned in the US, there are several others which have replaced it.

Getting down to BUSINESS

S. Arun-Kumar R. Chandrasekar Kamal Lodaya Paritosh Pandya R. Ramanujam

THE evolution of computers was outlined in the previous article of this series (SCIENCE TODAY, March 1984). There is one common thread running through the history of computers: the motivation for automating computation has always come from one of the following two sources.

□ *Accounting* or more broadly the maintenance and processing of business data. This has now acquired the name of **data processing** or **DP.** The term is a misnomer, since all computer applications involve the processing of data, but we bow to common usage. Other terms used in this context are BDP (Business DP), CDP (Commercial DP) or EDP (Electronic DP).

□ *Mathematical* or *scientific* computations, that involve the calculation of certain quantities that are too difficult to obtain manually. We call this **Scientific processing** and abbreviate it to **SP.** Another, somewhat derogatory, term for SP is *number-crunching.*

These have been the two traditional applications of automated computation. A more recent development is *symbol processing,* where the emphasis is on handling data more complex than mere numbers. We shall examine symbol processing in detail later. Presently, we concentrate on computer processing in business and science

Data processing

DP encompasses a wide field, from the traditional task of *payroll* (printing payslips for employees) to sophisticated forms of *financial accounting, sales analysis* and *production planning.* The forms of DP output most familiar to us are electricity and telephone bills, and the marksheets issued by the examination Boards and Universities.

In DP applications, the central concept is a **data file.** Each data file is composed of **records** which in turn are composed of **fields.** Figure 1 shows records and fields in an employee data file for XYZ & Co. Each employee has one record describing himself, with fields for his name, salary, age, the department he is in, etc. The file might be stored on punched cards, tape or disk. The monthly payroll can be prepared from this data.

The standard model for DP systems is quite simple (see Fig. 2). All data pertaining to a company is stored in a **master file.** Every now and then, however, some changes will take place in the company. In case of personnel—people are recruited, fired or promoted; they retire or die. More drastic alterations are also possible: a new department is formed or a new pension scheme comes into effect.

Ec	Dc	Name	Rs	P
0923	ACC	ARVIND DESAI	1026	50
092C	SLS	ALBERT PINTO	523	75
0919	MKG	SHRIMAN JOSHI	890	40
0918	ACC	SETH DHANRAJ	7286	00
0916	MFG	SAEED MIRZA	1001	05

Fig. 1 Employee records of XYZ & Co Ec – Employee number Dc – department code

As changes take place, the original master file gets outdated. It should therefore be periodically brought up to date. A list of changes to be made also called **updates,** is prepared in a **transaction file.** An update program reads each desired change from the transaction file and modifies the master file accordingly. The transaction files are composed of records and fields, and are stored on cards, tape or disk.

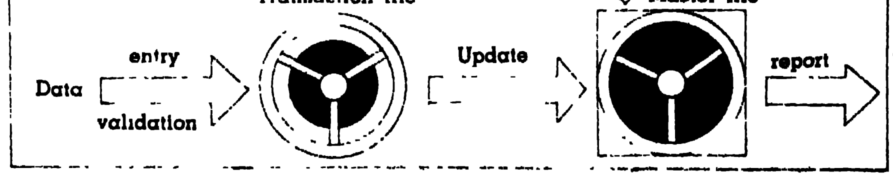
Programming for DP applications

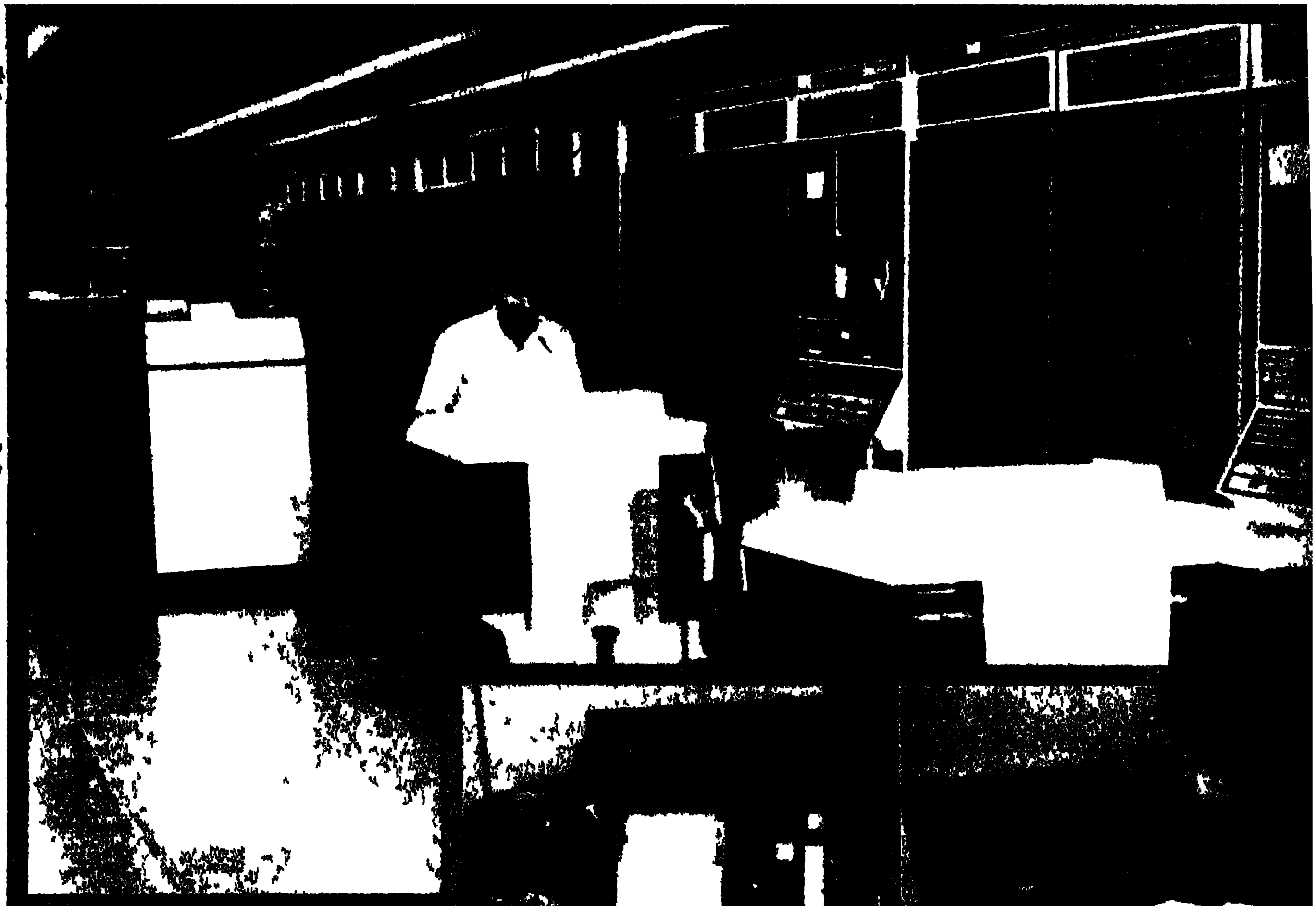
Let us start with the preparation of the transaction file itself. This is done in two stages: **data entry** and **data validation.** Entering a lot of data is a non-trivial operation—think of the number of deposits and withdrawals made by a bank in a single day. It is very probable that some mistakes will be made however skilled the data entry personnel may be. Sometimes, data entry may be performed **off-line** (at a different site from the computer) and some data may get lost or mutilated in transit. Punched cards are the time-honoured medium for data entry, but they are notorious in this respect—they get easily bent, torn or misplaced.

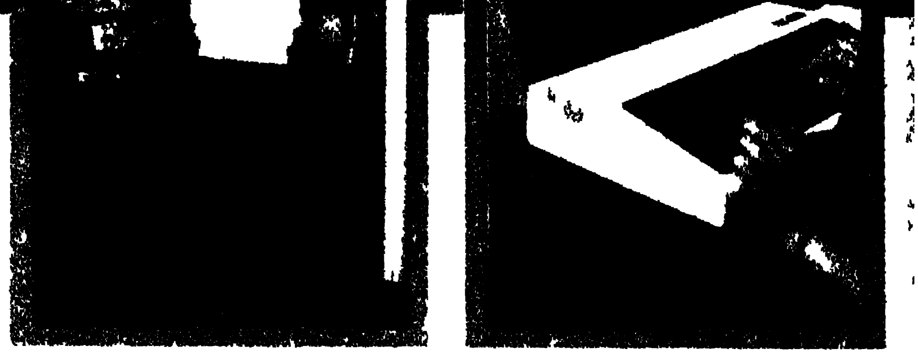
Does it matter if one record in a thousand is slightly disturbed? Well, imagine your cheque for Rs. 100 is entered as Rs. 1,000 by mistake. In order to avoid such costly mistakes the transaction file has to be **validated** that is, checked to ensure that it faithfully represents the original list of updates prepared by the company. Business data typically involve a very large number of records. So manuallly validating transactions may be virtually impossible. Hence, a program is used for the validation.

Even during the initial preparation of the master file which is also known

Fig. 2 The standard DP model







as a master file load a data entry and validation operation is required The transaction validation is just to check that no transaction is improper. For example, age field should have only a two digit number A master validation on the other hand will check *across* transactions as well (The salary of the manager should be greater than that of the employees under him)

From now on, the master file is assumed to be God Associated with the master is a set of **integrity constraints.** An example is "All credits and debits must add upto zero," which makes sense in a financial accounting system. When a transaction updates the master, the integrity constraints are checked Any transaction that threatens to violate these constraints is marked as erroneous and the master is not updated. This process is known as **updating the master.**

Each update—correct and erroneous—is printed out for examination. Along with these reports, a new file is generated which becomes the new master. the second incarnation of God, valid until the next update (see Fig. 3).

The final phase, in data processing achieves what the computer system was developed for—*report generation*—to produce information regarding the organisation (Fig 4) A whole battery of report generating programs may be developed to answer queries like

□ What are the salaries of the staff in the Accounts department?
□ Whose salaries have gone up by less than 10 per cent in the last five years?

These reports are to be printed out in the format prescribed by the manager or whoever wanted the report In the case of business forms such as payslips, marksheets etc the printing is done on specialised stationery.

DP Personnel

A DP problem is generally posed by a marketing executive The **systems analyst** then examines the data processing needs of the company and decides on what sort of information will be required, not only for the present, but also in the foreseeable future He/she designs the data files on this basis what sort of records should be present, what each field should mean, how should the various records be validated and so on Then the system of programs that operate on the files is specified, and a schedule for running programs is prepared

The actual operation of the programs is supervised by **operators** whereas the

TEST-TUBE FORESTS

A. F. Mascarenhas

IN THE beginning was the seed ...Then came the plant. Not any more. Thanks to the wizardries of genetic engineers you can rewrite the botanical genesis:

"In the beginning was the cell, any cell from stem, root, anther or leaf not necessarily a seed. From it you can regenerate the entire plant." So you have coconut palms being grown from a tiny clump of cells in the test-tube, rice being grown in brackish water by unconventional methods, newer, super varieties of tomatoes grown in frost...

New crops. New trees. New strains. Even rare and superior varieties are all easily available due to the revolutionary techniques of "plant tissue culture" developed over the last 20 years. As the name suggests, pieces of growing tissues of plants are taken, disinfected and cultured on a suitable medium. The mass of cells multiply and remultiply. On altering the conditions, the cells begin to reorganise into whole plants, exactly resembling the original parent plant. These carbon copies together constitute a clone.

How does one proceed?

When any plant part (shoot tip, stem, root, inflorescence, anther, leaf) is excised from a living plant it usually contains bacteria or fungal spores which will grow very rapidly in the medium (nutrient solution containing minerals, sugars, plant hormones, and vitamins). Consequently, before implanting of the plant material on a previously prepared culture medium, the first step is to free the medium of micro-organisms by sterilisation. Various media formulations are available, however that prepared by Toshio Murashige of the University of California, is universally used The medium includes various nutrients or chemical compounds, as produced and supplied by the parent plant. The culture medium may either be made semisolid by addition of agar or it can be left as it is. When grown on agar many plant tissues are known to form a mass of "undifferentiated" cells while agitated

A controlled temperature room for incubation of plant cultures (inset)

A Eucalyptus forest in Tamil Nadu showing fast-growing elite trees

TREES which help stop the erosion of topsoil have been chopped down wholesale for firewood. Ecologists regard this situation as serious but not hopeless. Using plant tissue culture barren forests can be reforested with millions of trees in no time

Large number of Eucalyptus shoots developing on medium on subculture

liquid cultures often produce cell suspensions. Such a mass is called callus. At this stage, the callus is a compact mass of small similar cells (with dense cytoplasm) wherein, no part of the plant (trunk, stem, leaf) can be distinguished. Plant growth regulators or hormones such as auxins and cytokinins are added to stimulate the cells to divide, forming roots or shoots. It is known that the formation of roots is stimulated by auxins, one of them, being α—naphthalene acetic acid and shoots by cytokinins such as kinetin, a purine derivative (6—furfurylaminopurine). In many cases a combination of cytokinins and auxins is necessary to produce a large quantity of shoots. The crux of plant tissue culture research is to look for the best combination of nutrients and hormones (a cook-book recipe) by a trial and error method to induce shoot production and/or root development.

Plantlet of Eucalyptus transferred to the pot

The property of the cells or plant tissues to regenerate shoots, roots or whole plantlets *in vitro* has wide application in micropropagation, mutant isolation and regeneration of protoplasts

Speeding up tree propagation

For many years horticulturists have maintained the genetic characteristics of selected individual plants over successive generations by producing new plants from cuttings of grafts of the superior stock This method is known as vegetative propagation which is now being used by foresters for the genetic improvement of many forest trees. The seeds of these trees are produced by natural wind pollination and have been found to produce stock with improved growth rates Also, better results can be obtained if the seed is produced by controlling the pollination between the superior trees However hand pollination is a time consuming and labour intensive operation, even if it is directed only towards making a fair amount of superior seed Known methods, on the other hand give only a small multiplication advantage. A more recent form of vegetative propagation called micropropagation using tissue culture has the greatest multiplication advantage It is a process of producing new plants in large numbers under a sterile atmosphere from very small pieces of selected plants or tree tissues.

Plantlet formation by micropropagation can follow two separate pathways. Plantlets can be produced from the shoot tips or other primary explants directly. They can also be produced via the formation of intermediate callus. This process of plantlet formation or development of a complete plant is known as organogenesis. The second pathway involves the formation of the so-called somatic embryos or embryoids from the callus. These embryoids are analogous to the normal embryos. However, they contain genetic material from a single parent—they are clonal.

The pieces of plant tissues are cultured and grown on a soil free medium where the explants pass through three major stages. Stage 1 is the formation of multiple shoots. Stage 2, the formation of roots on the shoots and stage 3 the hardening of the rooted plantlets to withstand their transfer to field. To get a culture started, the shoot tip or any other actively growing region measuring about 10 mm is implanted on the culture medium. When it gets established in its new environment it begins sending out new shoots. These new shoots are separated and transferred to fresh media to produce more shoots. This multiplication process can be repeated every 3 to 4 weeks to produce thousands or millions of shoots in a year.

Micropropagation is one aspect of tissue culture which is widely used commercially. Using this technique, Eucalyptus shoot cultures were grown in the culture medium containing cytokinins. Every sub-culture, produced about 50 shoots at the end of three weeks. The shoots were then made to root in the presence of auxins. It was estimated that just one shoot tip would yield nearly a million plants in a year.

It has been proposed that embryoids could possibly be encapsulated and then handled as seeds. Laboratories around the world are presently attempting to develop such systems so that the procedures for plant production and sowing can be mechanised. Such

Dissection of an explant before inoculation

methods would bypass the necessity of time consuming and costly labour intensive operations at different stages. At least 50-80 per cent of all direct production costs can be attributed to technical and skilled labour involved in plant collections, sterilisation procedures, and administrative costs. Rapid progress is being made in this field and one can be optimistic of the economic feasibility in the development of practical systems for mass scale production of plantlets from genetically selected forest tree species.

Tissue culture for forestry

Earlier, tissue culture—investigators concentrated on herbaceous species because these herbs tended to yield uncontaminated cultures which generated plants with relative ease. Woody plants have till recently been ignored because they are more difficult to propagate and were considered recalcitrant. They present problems for isolating uncontaminated cultures and of inducing root and shoot differentiation either from callus or tree explants. However, the recent successes with mature trees of teak, eucalyptus, poplars and pines in India and with seedlings of pines and poplars in other countries, have renewed interest in the use of tissue culture and have indicated the vast potential of its use in forestry.

Tissue culture techniques have now yielded tall majestic trees having a faster growth rate for fuel, better wood quality for timber or pulp production and higher edible products or oil yields. However, due to cross-pollination, the progeny raised by seeds is not identical to the parent.

In order to produce trees of the same kind in large numbers, this technique can be well utilised. Plant material could be picked up from a large number of genetically diverse individual plants of different desirable genetic traits, brought to the laboratory and mass multiplied. The plants produced can then be remixed in the plantations thus reducing the odds whereby the whole plantation can be wiped out by disease. The potential of such a massive multiplication programme could be estimated from the impact it could have in farm forestry programmes for increasing the fuelwood capacities of the plantations.

Growers may one day buy cultures instead of seeds to meet the future crop requirement. Studies on the refinements of these techniques are being developed so that they can cut the present costs to a fraction. The present cost of mass producing seedlings for production-forestry from shoot tip cultures is of much concern to researchers and foresters alike but appears to hold the greatest promise for immediate application.

In addition to the use of micropropagation for regeneration of high value mature trees selected for specific genetic traits such as wood quality, form, growth rate, pest and disease resistance, the method also holds promise for cloning genetically improved seedlings produced by controlled pollination in seed orchards. The demand for wood as a renewable energy source of biomass is projected to double by the year 2000 both in the developed and developing countries. Its use will help reduce our dependence on fossil fuel.

In India 68.5 per cent energy is used in the form of firewood in household sectors. However, on account of population pressures, the demand for firewood has outstripped the natural regeneration and planting, so much so that in some areas though there is food to eat, not enough wood is available to

cook the same, resulting in depletion of the forest cover. One of the alternatives is in selection and mass scale replication of fast growing identified trees. Such tree plantation programmes will help to increase the overall yields of fuel which at present is barely over four dry tons of wood/year to about ten times this amount if the tissue culture-raised trees from the fast growing stock are all identical in growth rates with the parent clones.

Using tissue culture it is possible to increase the vigour of tree clones by meristem culture for the production of disease free clones. The ability to multiply cells that are free of virtually every known disease in tissue culture, has eliminated the need for quarantine and international shipment.

More long-term projects where some progress has already been achieved is in the introduction of new genetic variation in clonal plants by development of techniques for *in vitro* mutant selection. Simple selection procedures for creating stress conditions within the medium can be developed. Plant scientists add chemicals that stimulate drought to the cell medium and create other hostile stress conditions like salinity, alkalinity, disease toxins, etc. Surviving cells are then coaxed to multiply. By repeating the process many times, cells and plants that flourish under these adverse conditions can be developed.

Isolation, culture fusion and regeneration of somatic hybrid plants by fusion of plant protoplasts (cells freed of their cell walls by hydrolytic enzymes) or by recombinant DNA techniques also show tremendous potential. Not only can cell fusion produce hybrids that would otherwise be impossible but additional agents such as genetic material from another plant (that confers certain desirable traits like disease resistance) can be introduced into the isolated protoplast. This may alter the genetic make up of the resulting plants. However, once the cells have fused, problems in concocting the right regenerative and rooting formulae can be enormous.

Rooted plantlet of eucalyptus

The new techniques of somatic hybridisation or genetic engineering overcomes sexual barriers and can make wide crosses between different plant families or kingdoms, possible. These techniques are still very elementary, but they have advanced sufficiently so that one can expect a faster production of new plants and varieties.

Another application of tissue culture in forestry would be in its use for production of haploid plants from the germ cells (pollen grains). Each parent is diploid that is, it contains two sets of chromosomes. Germ cells are haploid having half the number of chromosomes. In other words, it contains just one set of chromosomes acquired from the parent. These haploid germ cells develop into a haploid plant. The haploid embryo is subjected to colchicine treatment. Colchicine causes plants to double their number of chromosomes. The haploid hybrid splits its chromosomes and becomes diploid having two sets of chromosomes Actually, it is not a true diploid but it is a 'di-haploid'. This di-haploid is perfectly homozygous or uniform. Isolation of haploid cultures would help in a quick production of pure lines.

An increasing awareness that tissue culture can also play an important role in rapid multiplication and maintenance of sterile plants as an alternative to seed storage of germ plasm for preservation of the identified elites from different locations, is developing. Such a conservation strategy would reduce the danger of accidental loss of invaluable germ plasm and also of tree species which are gradually becoming extinct. Several copies of these trees can be stored in the laboratory and used when required in any breeding programmes, based on their specific adaptability. There is a recently published report in the National Academy of Sciences of USA on Humanities destruction of Tropical forests and the necessity for a massive effort for collecting germ plasm in tissue cultures.

Future prospects

Barely two decades ago plant tissue culture was just a basic research tool. Since the last ten years several commercial laboratories have sprung up producing millions of plants by organogenesis, although cloning of mature forest trees has been achieved only since the last 5 years. In addition, attempts are also being made to produce somatic hybrids and genetically engineered and mutant trees. Embryogenesis from forest and other plants is still rare and offers many problems. The emphasis now rests with the process engineers for refinements of the technology which is at present highly labour intensive to a low cost conveyor belt mechanised technology for the manufacture and sowing of millions of plants. This will reduce the present concern over the costs in mass production of forest trees required for any farm forestry programmes.

The progress is rapid and we are on the threshold of many more revolutionary changes for mass scale manufacture of plants and the creation and evolution of an entirely new class of plants and trees. As our knowledge of plant growth and development gradually increases we can look forward to tissue culture making many more significant contributions to plant breeding, agriculture and forestry before the turn of the century. □

Dr Mascarenhas is a scientist in the Biochemistry Division of the National Chemical Laboratory, Pune, where he is working on plant tissue culture

TISSUE CULTURE IN ORNAMENTAL PLANTS

Vibha Dhawan

Sant S. Bhojwani

Shoots arising from protocorms formed by shoot-tip of Cymbidium orchid

ORCHIDS are the most sophisticated plants of nature. They are unique in several ways. The structure of their seeds and mode of germination is very distinct from the other flowering plants. Further, the commercial varieties of orchids do not produce seeds. Those of which do, show a great variation in the progeny. Also, the conventional methods of vegetative propagation of orchids are extremely slow.

It was in 1964 when a French Botanist' George Morel achieved success in growing orchids using aseptic cloning or tissue culture technique. This revolution in orchid industry came through accidentally. While attempting to raise virus-free plants of *Cymbidium* by culturing less than a millimetre long shoot-tips from infected plants of the orchid, he observed that these 'microcuttings' instead of developing into leafy shoots, formed spherule—like structures with rhizoids at the base. These structures were identical to the protocorms (original plantlets) normally formed by embryo during seed germination. Each shoot-tip produced a clump of about half-a-dozen protocorms. If the proliferating mass of protocorms, before the formation of plants, was sliced into 3 to 6 pieces and placed on fresh medium, each one grew and budded off into 4 to 8 protocorms within a month's time.

"In the nursery shops, guaranteed pathogen-free plants can be bought as novelty items in attractive containers"

This process of protocorm multiplication could be repeated indefinitely. If, however, the protocorms were not chopped, each one of them developed into a plantlet. Morel estimated that even if each protocorm gave only four new plants in a month, it should be possible to raise over four million plants in a year starting from a single shoot-tip. Appreciative of the great potentials of this new technique, the commercial orchidologists rapidly adopted the aseptic method of cloning orchids. The methodology developed by Morel has been further refined over the years. Practically all economically important orchids are presently propagatable through tissue culture. Indeed, tissue culture is currently the only economically feasible method for clonal propagation of orchids. All major orchid growers the world over, now have well established tissue culture laboratories.

Multiplication of other plants

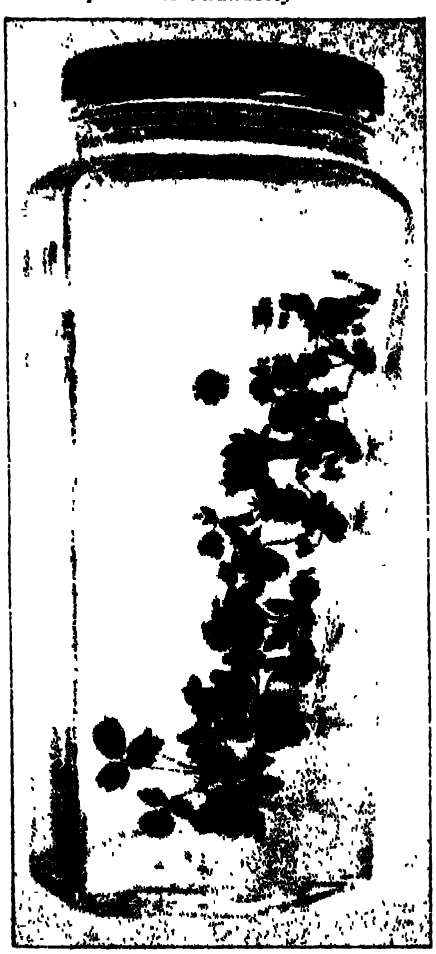
General interest in aspetic cloning of plants arose from the grand success with orchids. The exciting breakthrough in orchid industry, prompted the horticulturists to use this technique for propagating various other ornamental and orchard plants.

During the last two decades the development in this field has been so impressive that numerous nurseries in the developed countries have acquired well established tissue culture laboratories. They are routinely using the aseptic methods for clonal propagation of ornamental, fruit and forest species. In the USA, plants propagated aseptically are sold in the nursery shops as guaranteed pathogen-free plants and can be bought as novelty items in attractive containers.

In tissue cultures, a piece of stem, leaf or root can be induced to form an unorganised mass of tissue, called callus. By manipulating the relative concentrations of growth regulators in the medium, the callus may be multiplied indefinitely or made to form several shoots. Certain plants like citrus, coffee, date, palm, grape, sandalwood and many cereals undergo asexual embryogenesis. The undifferentiated tissue (callus) or pieces of stem or leaf differentiates into innumerable *asexual embryos*. These embryos are capable of direct plant formation. However, for clonal multiplication of an elite plant, the direct shoot differentiation from the original explant (adventitious shoots) is favoured.

In nature, several plant species, (African violet, begonia, blackberry, peperomia) are known to strike adventitious shoots from root, stem or leaf pieces. This potentiality of the plant cells is routinely used in conventional methods of vegetative propagation. In cultures, the number of buds produced per unit tissue of such plants can be several folds greater than its natural tendency. Pieces of leaves as small as few millimetres, which cannot even survive in nature, would differentiate into multiple shoots under culture conditions. Each one of the twenty fragments of a millimetre long shoot-tip of grape when cultured, produces several shoots. The aseptic multiplication of Boston fern involves gentle grinding of shoot-tips in a blender and plating the chopped material in semi-solid medium. Numerous adventitious shoots/plantlets develop in each plate. Several plants (chrysanthemum, gladiolus, tomato) which normally do not form adventitious buds, do so in tissue cultures under the influence of growth regulators.

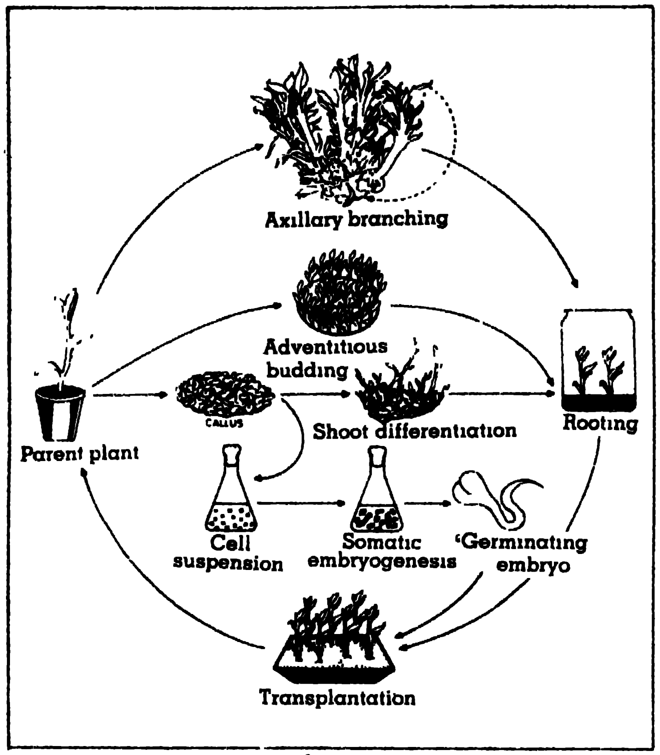
Rooted plants of strawberry



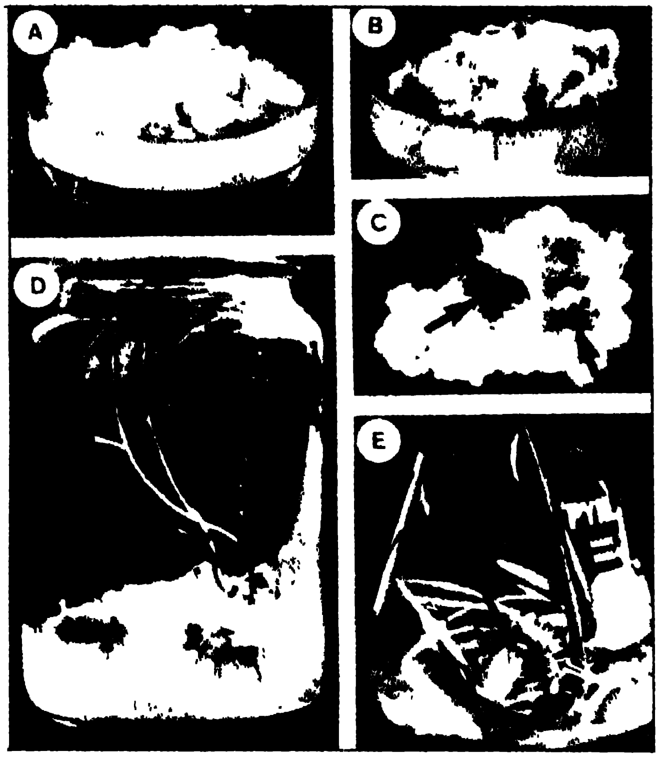
The only plants whose clonal propagation through adventitious shoot multiplication is risky are chimeric horticultural species, where a plant organ is made up of genetically different cells. For example, in variegated pelargoniums, the shoots arising from white segments of the leaf are solid white while those originating from the green segments are pure green. This splitting of chimera is horticulturally undesirable.

The method of axillary branching for aseptic multiplication of shoots is most akin to the conventional methods of vegetative propagation. The method is based on "Apical Dominance", a phenomenon in plants which refers to the suppression of growth of lateral buds on a stem by actively growing terminal bud. In 1958, Wickson and Thimann in the USA, showed that a lateral bud can be stimulated to grow into a branch even in the presence of a terminal bud by the exogenous application of cytokinins (growth regulators) In cultures, due to the continuous availability of cytokinin, the axillary buds on the original shoot directly develop into branches. This precocious release of axillary buds from apical dominance may be repeated several times in the same culture, transforming the initial explant into a bushy structure. After 4 to 6 weeks, if the individual shoots are excised and planted on fresh medium of the same composition, the shoot multi-

"The number of shoots increases logarithmically and within a year astronomical figures can be arrived at"



Diagrammatic summary of steps involved in aseptic multiplication of plants



(A) The callus of wheat plant (B) Root differentiation (C) Differentiation into shoot buds (D) Rooted plants (E) Flowering of plants

plication cycle may continue. This process may go on indefinitely round the year. The method may be initially slower (5 to 10 fold multiplication every 4 to 6 weeks) as compared to the other aseptic methods of shoot multiplication. However, the number of shoots increases logarithmically and within a year astronomical figures can be arrived at. According to Boxus from Belgium, several million strawberry plants could be raised through axillary branching starting from a single mother plant in a year.

In certain plants, like blueberry, feijoa and rhododendron, it is convenient and economical to treat the tiny shoots formed in culture as mini-cuttings and root them under non-sterile conditions in the glasshouse. For *in vivo* rooting of the aseptic shoots their basal cut end is dipped in a standard rooting powder (commercially available) or an auxin in talc and planted in a potting mix (1:1 pumice and peat). Scientists at the laboratory of Horticultural Science, Belgium are routinely using this method in commercial micropropagation of several ornamental plants (*Begonia, Cordyline, Dieffenbachia, Dracaena, Ficus, Spathiphyllum, Manihot*) with up to 100 per cent success rate. However, *in vivo* rooting is not applicable to all species that have been micropropagated as their unrooted shoots do not survive transplantation. In such cases individual shoots measuring about one centimetre in length are excised from proliferating shoot cultures and transferred to another culture medium containing an auxin for *in vitro* rooting.

Transfer of plants out of culture

Plants grown in cultures are very delicate and require special handling. Due to very high humidity (almost 100 per cent relative humidity) inside the culture vials the leaves of these plants do not acquire the usual protective surface layer, the cuticle. Consequently, these plants are extremely susceptible to moisture stress. As a rule, the plants transferred out of culture are initially maintained under high humidity (90 to 100 per cent) by keeping them under intermittent mist or covering them with clear, transparent plastic. Small holes are punched in the plastic cover for air circulation. Partial defoliation of plantlets and application of antitranspirants (substances preventing the loss of water from aerial parts of the plant), such as acropol (1 per cent v/v) have also been used to reduce the loss of water from the plants. After 10 to 15 days under high humidity the plants are transferred to greenhouse bench and maintained in shade for another 4 to 6 weeks. They are then ready to be shifted to normal greenhouse conditions or transferred to the field.

Applications of micropropagation

Micropropagation holds special significance in situations where the stock material is extremely limited and it requires rapid bulking up. In order to

"India with its vast and varied flora is in a unique position to exploit this technique"

establish a reasonable sized stock from the material in hand, conventional methods may take several years. This period can be significantly reduced by efficient micropropagation techniques. Countries such as Australia and New Zealand even permit direct importation (without going through quarantine) of plant material in aseptic cultures which can be used as ready nucleus stock for aseptic multiplication. Rapid bulking up of plant material is also required in breeding programmes where generally there is just one plant with a set of specific desired characters. Micropropagation seems ideal for safe and rapid multiplication of such valuable genotypes.

In cases cited above, micropropagation may be required only in the initial stages of 'explosive multiplication' to build up a few thousand plants. Subsequently, the conventional and semi-conventional techniques of propagation may become more feasible than the aseptic techniques which may prove unnecessarily expensive. However, for ornamental annuals and many perennial woody cultivars, plants or cut-flowers are in large demand, almost throughout the year. For these cultivars, tissue culture methods have proved profitable for their continual propagation. The popularity of micropropagation overseas has reached a stage that ready made media mixes for specific crops have become available in the market as dry powders.

Vegetative propagation is extremely important in dioecious species (plants with the two sexes distributed on separate individuals) where seed progeny yields both male and female plants with equal frequencies. However, plants of any one of the sexes are more desirable commercially. For example, in *Asparagus officinalis* male plants are more valuable than the female plants but their clonal propagation by stem cuttings has not been possible so far. A micropropagation method developed for this crop starting from spears is now proving extremely valuable. In *Carica papaya* (papaya), another dioecious crop plant, only a few male plants are adequate to pollinate a comparatively large number of female plants. However, their seed progeny comprises of almost equal number of male and female plants which are indistinguishable until flowering. This results in considerable economic losses in terms of land utilisation. A solution to prevent such losses is to clonally propagate established elite female plants. Recently *in vitro* propagation of this fruit crop has been successfully achieved by Litz and Conover in the USA (Agricultural Research and Education Center, University of Florida), and Pandey in India (Indian Agricultural Research Institute, Delhi).

Aseptic storage of germplasm

Aseptic culture of plant tissues and organs is also a potentially valuable technique for storing germplasm safely and economically. The primitive cultivars and wild relatives of crop plants constitute a pool of genetic diversity which is invaluable to future breeding programmes. Clonal material of these plants is traditionally maintained in nurseries or fields which is extremely expensive and runs the risk of the material being lost as a result of environmental hazards. However, in cultures, relatively little space is needed for the preservation of a large number of clonally multiplied plants. Also, the plants are maintained free from pests, pathogens and viruses. Normally the cultures are to be divided after a growth period of 4 to 6 weeks and transferred to fresh medium (*subculture*). Storing of cultures at lower temperatures (1 to 9°C) cuts down the labour and cost of *in vitro* maintenance. Strawberry plants stored for 6 years at 4°C without a subculture were fully viable. At low temperatures, the metabolism of the plant is slowed down considerably, thus, reducing the need of replenishing the medium. Theoretically, the plants can be stored indefinitely if their metabolism can be completely stopped. This is being approached by preserving small shoot-tips and embryos at the super low temperatures (−196°C) of liquid nitrogen. Numerous workers have shown that cultured plant cells and organs do not lose their viability and capability to produce plants (totipotentiality), when freeze-preserved at the temperature of liquid nitrogen. Prairie Regional Laboratory, NRC, Canada, was able to maintain shoot-tips of strawberry and pea at −196°C for two years which on reculturing grew into full plants. Attempts are being made to develop simplified routine procedures for freeze preservation of cell lines and organs. At the International Potato Centre in Peru, shoot-tip culture is being used to maintain a part of the germplasm collection.

The method of aseptic multiplication of plants is no more an academic exercise. In the Western world it has already reached the industry and is becoming increasingly popular due to its multifarous advantages. The impact of these developments is already felt in India and several Government institutions are engaged in developing methods for the propagation of indigenous crop plants. Notable among these research centres are Bhabha Atomic Research Centre (Bombay), Indian Agricultural Research Institute (IARI), (Delhi), Indian Institute of Science (Bangalore), National Botanical Research Institute (Lucknow), and National Chemical Laboratory (Pune). India with its vast and varied flora is in a unique position to exploit this technique of *in vitro* propagation to its economic advantages, by micropropagating a variety of orchids and other ornamental plants commercially.

The Department of Environment, Government of India is seriously considering application of aseptic methods for the multiplication and conservation of endangered economically important plant species of India.

Vibha Dhawan is involved in developing aseptic methods of propagation for indigenous tree species for her Ph D programme.

Dr. Bhojwani is a research associate in the U.G.C Centre of Advanced Study in Botany, University of Delhi. He has been working in the field of plant tissue culture since 1964.

What does the future have in store for our children?

THE THEME selected for the World Health Day, 1984, is Children's Health—Tomorrow's Wealth. Each year since 1950, an important issue of public health has been highlighted by the World Health Organisation (WHO) to mark the World Health Day, 7 April, the date when the WHO's constitution came into force in 1948. The theme is an apt choice for it is high time that we seriously re-examine our health-care model and start giving to our children and their health the attention that they deserve. Any nation which neglects them does so at its own peril.

To address ourselves to this problem is a difficult task, more so in India and in other Third World countries which face problems of overpopulation and poverty and the consequent malnutrition and child abuse. Often children have to work to support their families or look after their younger brothers and sisters. These children form a significant proportion of our population, all living below the poverty line.

In India, the infant mortality rate (for children up to one year) has ranged between 120 and 130 per thousand for the last 30 years. Pregnancy and child birth is not always a happy event. The mortality rates of the newborns (from the first day of being born to a one month baby) in the rural areas where 80 per cent of children are born, is 76 per 1000; in urban areas it is 34.7 per 1,000. Mortality during the first four weeks of life constitutes more than 50 to 60 per cent of the total infant mortality. It is also known that almost 30 per cent of infants born are 'low birth weight' babies and these infants contribute to over 60 per cent of infant deaths. A new born's weight at birth is a legacy for its health in infancy and childhood.

These figures speak for themselves. The state of the health and care of children is dismal indeed. And a similar situation is known to prevail in several other underdeveloped countries which today constitute two-thirds of the world population. The main reasons for this child wastage are poor nutrition and anaemia of the mother, especially during pregnancy, failure to protect the mother and the newborn against tetanus (a bacterial disease marked by tonic spasm of voluntary muscles), and other infectious diseases, poor care at delivery and in the postnatal period, poor nutrition of the child and a failure to prevent infections after birth.

There are close interlinks between the mother, child, society and social development. Hence, the focus on child-health is not to be viewed in isolation—it is a developmental issue for a nation, in fact, for the whole world. The input for child health is to be viewed in the context of an improved social development.

Care at all levels

Care of a baby starts much before it is born or even before it is conceived. The mother must be physically and mentally mature to bear the baby and the accompanying responsibilities of tending it well. The babies, two or three,

should be well spaced out with an ideal gap of two to three years between the children. This time period enables the mother to regain her lost strength and the children can more or less grow together and be company for each other. Needless to say, a mother should be well cared for during pregnancy, she must be on a well-balanced, nutritious diet, with special attention to avoiding anaemia, so common among Indian mothers. Active but not over-strained, an expectant mother should include occasional rest in her daily routine. Of course, this is far from true in many cases in India. Even today, there are numerous instances of young girls aged five or so, or even newborns being married off and bearing children immediately after puberty. They often work 12 hours a day, in fields, factories or at construction sites, with little time to look after their babies, born or unborn. All this happens in spite of the laws forbidding child marriage, etc.

The foundations for adult health are laid in childhood and adolescence. Any damage to the foetus antenatally or during delivery or postnatally may lead to a mentally or physically damaged baby. A child once born should be well cared for and its physical needs satisfied. It should be adequately protected from different infectious diseases. All over the world there are frequent cases of child abuse and neglect.

In India, the problems are mainly of malnutrition and infectious diseases. Of the infections, diarrhoeal diseases and respiratory infections, including tuberculosis, are the main culprits The term 'nutritionally battered child' is used for victims of severe kwashiorkar (a tropical disease due to insufficient proteins in the diet), xerophthalmia (vitamin A deficiency) and rickets. These diseases pose serious problems as they cause permanent disabilities or deformities in children. About 40,000 children go blind each year due to xerophthalmia. The role of emotional neglect in the etiology of kwashiorkar is also worth considering, since it starts with failure to breast-feed and later intensifies with unsatisfactory weaning.

A basic level of health care is the right of all people and not only of the privileged few

In India one half to one million infants die each year of tetanus caused by crude midwifery practices—the umbilical cord is often cut with an unsterilised instrument. Diarrhoea and other gastro-intestinal diseases, caused by unhygienic and unsanitary conditions including the use of unpotable water, claim many young lives year after year; 2.5 million are affected while 1.5 million die every year. Simple concepts of hygiene and a scientific approach coupled with preventable measures could save millions of lives and money, which is now being spent on anti-diarrhoeal drugs.

The recent approach of popularising oral rehydration therapy for diarrhoea is to be welcomed—the idea is to prevent dehydration of the child. Recurrent bouts of diarrhoea coupled with inadequate feeding results in weakening the body and subsequently diminishes its capacity to fight diseases. Alternatively, continuous sipping

of a solution of potable water containing sugar and salt in 2:1 proportion will also prevent dehydration.

Other infectious diseases like diphtheria, poliomyelitis, measles, tuberculosis and whooping cough (pertussis) which kill or maim children can be prevented by an effective immunisation programme. This brings into focus the necessity of a well-geared primary health care system in a community. Unfortunately, many Indian mothers are still ignorant about the beneficence of immunisation. More seriously, adequate immunisation facilities are often not available to many children in villages. Here mention must be made of the National Expanded Programme on Immunisation (EPI) undertaken by the Government of Tunisia, Africa. The achievements are noteworthy—since its inception in 1978, over 80 per cent of the children have received BCG and 60 per cent have received the full dose of both DPT, (diphtheria, pertussis and tetanus) and polio immunisations in 1979. Statistics reveal that the EPI is already making an impact on mortality and morbidity among the young population in Tunisia.

Psychological development

For the overall healthy development of a child, we should not overlook its psychological and social needs. Love, understanding and encouragement stimulate the healthy development of a child. This process starts right at birth when the mother breast-feeds her baby. Breast feeding, of course has an added advantage of conferring immunity to the baby against infectious diseases, as the mother's antibodies are passed on to the baby through its milk. The practice of separation of the baby from its mother immediately after birth, supposedly to give rest to the mother and to protect the baby from infections, is also being questioned more and more by experts from the viewpoint of the psychological development of the baby. These quarters advocate close interaction between the mother and the baby right from its birth.

Play is also essential for normal development and is a basic right of every child, whatever its social or economic status may be. Fostering of play is the latest approach being

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P. K. Iyengar is BARC director

DR. P. K. IYENGAR has been appointed Director of the Bhabha Atomic Research Centre in Bombay. Till now the director of the Physics and Chemical Groups of the Centre, he succeeds Dr. Raja Ramanna, who earlier took over as the Chairman of the Atomic Energy Commission.

Acknowledged as one of the leading nuclear physicists, Dr. Iyengar started his research career in 1952 in the Tata Institute of Fundamental Research and later moved to the BARC (both institutes at that time being under the Atomic Energy Commission) Incidentally, he was Dr Ramanna's first student for Ph D, which he obtained from Bombay University

Dr Iyengar had played a crucial role in designing the Purnima (Plutonium Reactor for Neutronic Investigations in Multiplying Assemblies) reactor in 1972, a forerunner of the Pulsed Fast Breeder Test Reactor now reaching completion at Kalpakkam, Madras, and later in the atomic device exploded in Pokhran in 1974. His work on neutron scattering is widely known, and several of the innovations he made in neutron scattering techniques are now used all over the world.

Dr. Iyengar received the Shanti Swarup Bhatnagar Award for research in physical sciences in 1971.

Hari Om Ashram awards

The following are the recipients of the Hari Om Ashram Dr. Vikram Sarabhai Research awards for 1983:

Dr. S. K. Gupta of the Physical Research Laboratory, Ahmedabad, and Mr. S M Rao of the Bhabha Atomic Research Centre, Trombay, share the prize for research in atmospheric physics and hydrology. The other award winners are Prof. Biswanath Chatterji of the Indian Institute of Technology, Kharagpur, for research in electronics and telecommunications, and Mr P. S. Goel of the ISRO Satellite Centre, Bangalore.

The awards, endowed by the Hari Om Ashram, Nadiad, are made bi-annually for work in electronics and telecommunication, planetary and space sciences, atmospheric physics and hydrology and systems analysis and management problems.

Kalinga Prize

Dr. Osaldo Frota-Passoa from Brazil and Prof. Abdullah al-Muti Sharafuddin from Bangla Desh have been awarded the Kalinga Prize for science writing for 1982 and 1983, respectively

M. N. Parikh

Dr. Mahendra N. Parikh, honorary professor of obstetrics and gynaecology at the Seth G. S. Medical College, Bombay, has been elected president of the Federation of Obstetric and Gynaecological Societies of India for 1984-85

ENTER RNA - THE NEW ENZYME

MOST biological reactions occur at the body temperature of 37 C or nearabouts In order for the reactions to occur efficiently, they need to be catalysed right? Right. And these catalysts are called enzymes, right? Right And all these enzymes are proteins, right? Well not so right any longer! That RNA (ribonucleic acid) can act as a biological catalyst has now been reported by Dr S Altman and his group at the Department of Biology, Yale University, Connecticut, USA in two papers (*Science*, **223** 285 and *Cell*, **35** 849) With this demonstration of the intrinsic 'enzymatic' activity of RNA, the dogma that only proteins can catalyse biological reactions in the cell has to be discarded

When a cell biosynthesises a protein, the message is first transcribed from the genome as a messenger RNA which reaches the ribosome, the site where the actual protein synthesis occurs Besides this specific transfer RNA (t RNA) molecules are also transcribed from the gene The role of each t-RNA molecule is to couple with a specific amino acid and transport it to the ribosomal site At the ribosome, appropriate alignment of each of these amino acid carrying t-RNA occurs by triplet base-pairing (the codon-anticodon recognition) with the messenger RNA sequence, and the amino acids that are coupled to each t RNA are sequentially aligned, peptide bond formation occurs and the protein chain is thereby synthesised

All these t-RNA molecules are first transcribed from the genome as larger precursors that are later enzymatically processed, i.e , a part of the molecule is chopped off, to produce mature t RNA molecules that are functionally active This processing of the precursor t RNA is catalysed by the substance termed ribonuclease P, which contains five times RNA to protein by weight It is this reaction that Dr Altman had been studying for about ten years, and during this study the suspicion grew that the RNA component of ribonuclease P might be the catalyst for the processing reaction In their consummate paper that appeared in *Cell*, Altman and coworkers have fractionated ribonuclease P and isolated its RNA and protein components They established that the isolated RNA indeed catalyses the reaction while the pure protein component does not

In another experiment, they isolated ribonuclease P from two microbial sources, *E coli* and *B subtilis* and fractionated them into their RNA and protein components, and then recombined them as mixed or heterogenous complexes, i e *E coli* RNA + *B. subtilis* protein, and vice versa Such heterogenously constituted ribonuclease P particles were seen to catalyse t-RNA precursor processing as well, particularly at high concentrations (0 06 molar) of added magnesium ions During this experiment, it was discovered that at high magnesium concentrations, just the RNA component alone would catalyse the reaction!

But does the catalytic activity arise really due to RNA alone or due to some protein contamination? This nagging doubt was set at rest in the *Science* paper, where the authors prepared the RNA by in vitro transcription of the corresponding genome and studied its processing efficiency towards the precursor of tyrosine t-RNA This not only obviated the possibility of protein contamination but also showed the inherent catalytic ability of the transcribed RNA molecule, establishing thereby that biological catalysis can occur by RNA as well.

As often happens in science, once the mental barrier about a dogma is broken, rationalisations and extensions of the discovery and the idea abound Will other instances of catalysis by RNA be found? The likely candidates appear to be the protein-RNA complexes of the ribosome itself, the ribonucleoprotein (RNP) particles in the nucleus, cytoplasm, the RNP particle that recognises the "signal" sequences in proteins that have to be transported from the ribosome to the cellular exterior, and several small RNAs whose roles are at present unclear There is also a Russian report of an RNA-containing enzyme that modifies the sugar amylose If this were to be an inherently RNA catalvsed reaction, it would be the first example of an RNA catalysing a reaction on a non-RNA substrate And of course, could RNA have played a catalytic role during biological evolution and thus save us the paradox of which came first, protein or nucleic acid?

What might cause the catalytic property of RNA? Interestingly, this might be related to the highly flexible and "globular-type" chain architecture that RNA can adopt in solution. Such a folded form would be able to provide crevices and pockets, namely binding and catalytic surfaces with appropriately juxtaposed charged phosphate groups, reminiscent of protein catalytic surfaces The requirement of magnesium ions in the catalytic activity of RNA is in accord with this structure-function idea and also suggests that even small RNA sequences, natural or chemically synthesised, might be catalytically active in salt-containing media the added salt might reorganise the secondary and tertiary structure of the RNA into appropriate and specific forms suitable for binding and catalysis Such a flexibility does not appear to be possible, at least at first glance in the double helical molecules of DNA which tend to be rodlike and not so flexible, and thus rather prosaic in this context However, some polysaccharides and lipopolysaccharides might turn out to be catalytically interesting, particularly since polysaccharides of the cell surface do have 'binding and recognition' sites But would some of them have catalytic sites, particularly those containing ionic and polar groups such as sulphate or amide? Do not be surprised if somebody shows soon enough that polysaccharides are biocatalysts too

D. Balasubramanian

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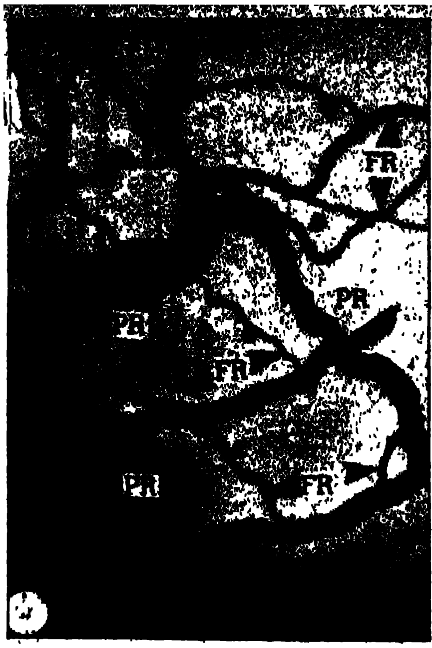
Inter-dependence among plant species

MOST plant species in natural vegetation as well as under cultivation are infected with fungi that grow in and around the roots Such fungi are known as mycorrhiza a name derived from the Greek words for fungus and root These associations are widely accepted as a part of normal plant growth and also regarded as beneficial for plants in obtaining nutrients from soil, especially in poor soils In the most common type of mycorrhiza, the fungal filaments grow between the root cells and produce specialised, bush-like, branched structures known as arbuscules inside the cells They also produce vesicules outside the cells This group of mycorrhiza are known as vesicular-arbuscular mycorrhiza

In plant communities such mycorrhiza make underground connections between the neighbouring plants of the same, as well as different species It has been reported previously that such mycorrhizal connections provide a channel for inter-plant transfer of carbon and phosphorus. However, experimental evidences were not equivocal, and the observations could also be attributed to leakage into soil from 'donor' roots and subsequent uptake by the



Closely intertwined roots of Plantago *(PR) and* Festuca *(FR). They are distinguished on the basis of their size, PR roots being more robust than those of FR*

Roots of Plantago *and* Festuca *in a specific (a) and field (b) inoculum system. Root hairs and the interconnecting endophyte mycelium (EM) form close interconnections*

roots of 'receiver' plants. Now Dr. R. Francis and D. J. Read of the University of Sheffield (*Nature*, **307** 53) clearly demonstrate the movement of carbon between the 'donor' and 'receiver' plant species through the mycorrhizal connections. They further show that the magnitude of transfer follows the well known 'source-sink' relationship.

The Sheffield botanists have demonstrated this by using a radioisotope of carbon (^{14}C). A dicot, *Plantago lanceolata* and a grass species *Festuca ovinia* respectively, were used as the 'donor' and 'receiver' plants. The two species were grown together in partially sterilised sand under two different experimental conditions. In one set there was no mycorrhiza while the other was inoculated with mycorrhiza. Six weeks later when the mycorrhiza was well established in the inoculated set, shoots of the *Plantago* (donor) plants were exposed to $^{14}CO_2$ for two days in both sets. Roots were carefully separated from soil and examined. The roots of the two species used are distinct and can be easily identified by their thickness.

In both sets, roots of the two species were seen in close physical contact. Later autoradiographs (images produced on X-ray films by radioactive materials) were prepared from the same samples. As expected, roots of the 'donor' species produced dark images in both sets. There was no trace of ^{14}C in the roots of *Festuca* from the non-mycorrhizal set, indicating thereby that though the roots of the two species were in close contact, there was no uptake of carbon. In the set inoculated with mycorrhiza, roots of both the 'donor' as well as the 'receiver' species showed the presence of ^{14}C. They also show ^{14}C in the mycorrhizal connections between the roots of the two species.

The authors have also quantitatively estimated the amount of ^{14}C in the 'receiver' species by scintillation counting (a sensitive, quantitative method of estimating the amount of radioactivity). Further, the 'receiver' plants were partially or fully shaded to reduce their own photosynthesis (carbon fixation). In mycorrhizal plants, a significantly higher amount of radioactivity was detected in the roots of the 'receiver' plant in comparison to the non-mycorrhizal plants. The amount of ^{14}C was further enhanced in 'receiver' plants grown in reduced light or in the dark. The 'receiver' plants showed 0.1 per cent of the labelled carbon of the 'donor' species.

The results reported establish that plants in natural vegetation connected to each other by underground mycorrhizal connections are inter-dependent for carbon assimilates. And, the inter-plant movement of carbon is governed by the differences caused by illumination. As the authors point out, long term studies are needed to obtain quantitative estimates of the carbon assimilates actually transferred during the life-span. It is implied that mycorrhizal infection in the early growth may be an advantage but at later stages they could be a drain on plants' carbon resources. The paper shows the complexity of the relationships between plants in a community and by analogy in the mixed cropping practised in many parts of the world. The paper also illustrates how relatively simple experiments can provide new, useful information when the right kind of questions are asked.

C. R. Bhatia

Dr. Bhatia heads the Mutation Breeding Section of the Biology and Agriculture Division, BARC, Bombay.

Computing with photons

A COMPUTER, based on light signals rather than on electric currents may well become a reality in the near future. What is even more exciting is the possibility that the optical counterpart of the electronic computer will be a thousand times faster.

The crucial component of a digital computer is the switch that can represent the values of 0 (off) and 1 (on), and the speed of a computer is limited partly by the switching time or the time it takes to go from one state to another. In an electronic computer, transistors are the switches and the fastest transistor now in use can flip in about a billionth of a second (nanosecond).

The optical analogue of an electronic transistor, called transphasor, is a relatively new concept in computer technology. This optical switch is, in fact, a combination of a semiconducting crystal and two laser beams. The off and on states of this device correspond to a sharp loss or gain in the intensity of the light transmitted by the crystal. Interestingly, the optical switch is found to flip in about a picosecond—a thousand times faster than the transistor.

The optical switch is essentially a Fabry-Perot interferometer, having an optically bistable material in the cavity (the refractive index of such a material varies with the intensity of light falling on it). The two laser beams are focused on the front end of the interferometer. One of them is strong and unvarying whereas the other is weaker and can be modulated. Due to the steepness in the transmission curve even small changes in the probe can result in large changes in the transmitted intensity.

Prof. S. D. Smith of Heriot-Watt University, Edinburgh, who has done pioneering work in the areas of optical bistability and optical logic gates, says, however, that only general statements can be made about the form an optical computer may take (*Nature* **307** 315). Apart from its inherent speed the optical computer may offer other advantages too, for example, in communication with light beams where thousands of channels can be carried without interference.

The first European conference to be hosted by the Royal Society on 21 and 22 March, to discuss exclusively optical bistability and photonic logic will probably tell us how close we are to an optical computer.

Indira Murthy

Dr. Murthy is on the editorial staff of SCIENCE TODAY.

GROWING GREEN

And down went my uncle/Sol/and started a worm farm
e.e. cummings
Nobody Loses all the Time

THE "worm farm" that cummings celebrates is no poetic fantasy of failure. Worm farming is a lucrative business. All over the world, researchers are rediscovering the virtues of the worm, both as the traditional "friend of the farmer" and as a valuable source of meat—not just for animals but for humans, too!

Welcome the worm. Move over pig. It's the latest entrant in mankind's menagerie of domestic animals. Worms are valued as waste-processors. They convert unpleasant animal slurries into compost and are themselves a rich source of protein. Putting worms to work, makes sound sense in these "Limits to Earth", ecology-conscious days. We shall examine the non-controversial use of worms first

Researchers all over the world have only recently begun to rediscover the earthworm's role in soil fertility. They have found that introducing earthworms into the soil can boost crop yields. Wheat yields can double, grass yields quadruple and cotton yields multiply fivefold

Soils without earthworms usually become dense and compact, thus discouraging plant growth But soils rich in earthworms remain loose, giving the soil a much better capacity to retain air and water (earthworms introduced into a test plot for a month increased the rate at which the soil could absorb water by 350 per cent) The earthworm's constant burrowing, mixing and digesting turn organic waste into fertiliser and garbage into soil nutrients.

The excrement or "castings" of earthworms, which consists largely of digested soil and particles of organic matter, is more chemically neutral than the surrounding soil So by consuming soil, processing it, and excreting the remainder as castings, sufficient numbers of earthworms help keep a field closer to the neutral pH range. Soil that is excessively acidic or alkaline can inhibit the growth of vegetation and micro-flora

Earthworms also transport minerals and subsoil compounds from deep in the soil, where they can languish beyond the reach of shallow root systems, to an area near the soil's surface. During the process the earthworms often transform these compounds into nutrients that plants can use much more readily. Chemical analysis of earthworm castings shows that they can contain upto two times as much available phosphorus and eleven times as much available potassium as the surrounding soil.

The passage of soil through the earthworm's gullet also greatly promotes bacterial growth. In particular, actinomycetes, bacteria that create humus, thrive in the presence of earthworms The actinomycetes contents in the castings is six to seven times greater than in the original soil

Through their constant burrowing, mixing and digesting, earthworms significantly improve the composition of the soil. It is observed that only after three days of earthworm action, test soilbeds had over 50% larger aggregates—clumps of silt, clay and sand particle—which form in the earthworm's gut; these aggregates are an essential component of productive soil which remains well aerated and resists erosion

The improved soil structures brought about by earthworms help plants develop longer and more penetrating roots Dr J A Van Rhee, a Dutch researcher, has found that in orchards "trees that had earthworms placed around them grew heavier root systems than did tree in soils without worms".

Because of the earthworm's ability to create fertile soil, naturally productive areas are often found to teem with earthworms. Dr. Heiberg a researcher at the New York State College of Forestry writes that "in good forest mull between 2.5 and 5 million earthworms are found per hectare weighing about one ton, their castings may amount to 37 tons per hectare per year. There is no doubt, that earthworms, are the most beneficial animals in forestry" Dr. Zrazhevskii, a Soviet forestry researcher, has reported that earthworms in forest soil increase the growth of 2-year oak seedlings by 26 per cent and of green ash seedlings by 37 per cent.

When organic wastes from human consumption are mixed with sewer sludge and animal manure, the earthworms can really get down to work In one California experiment, 8,300 kg of biodegradable refuse (after removal by hand of 820 kg of nonbiodegradable refuse), composed to materials ranging from phone directories to grass clippings, were 50 per cent consumed in 38 days and 80 per cent consumed in 68 days.

Today over 90,000 earthworm ranchers are raising and selling earthworms in the United States. Thousands of families are profiting from the environmentally beneficial activities of improving soil, breaking down wastes, producing valuable castings, and increasing the total biomass of earthworms capable of working for humankind.

BACKS FROM WORMS

Recently several large scale applications of earthworm composting have begun operating in the United States, Canada and Japan as a supplement to solid-waste processing systems

The first commercial annelidic or earthworm consumption facility was established in Canada in 1970 and is currently processing about 75 tons per week of biodegradable refuse. There are now in Japan four such annelidic consumption facilities processing about 10 tons per day principally for specialised manufacturing wastes.

Dr. Gaddie, President of North American Bait Farm is so convinced about its economics and potential for considerable growth in the future that his company has begun developing an earthworm-composting plant that could process refuse for a city of upto a million people. He mentions.

"A 200-ton-per-dav facility would require less than 100 acres of land to operate (land which would never fill up, as in conventional land 'ill operations) and (such) a facility could be established för less than $5,00,000 including land, equipment and starting stock of earthworms. Since the earthworms do virtually all of the work of continually turning and aerating the refuse, the only energy consumed in laying down the refuse, originally and picking up the castings, and in providing perimeter lighting for the worm rows."

Now consider the worm in its most controversial role: as man's meat. Worms, whether eaten as wonton soup or vermicelli (pun intended) are doubly repugnant to those brought up in centuries-old vegetarian traditions. Even those accustomed to such exotic non-vegetarian fare as sturgeon eggs (caviar) and birds' nest soup turn green at the thought of worms for breakfast, lunch or dinner.

But promoters of worm meat ask with impeccable logic: if you can eat a pig, why not a worm? After all the birds, both early and late ones, have been doing it for years. But opponents say men are not birds. Neither are women (whatever Eric *Partridge's Dictionary of Slang* may tell you). And thereby hangs a tale.

Before we turn to the arguments for including worms on our menu we must realise that sheer expediency and reason alone are unlikely to clinch the issue. Were that so, much of the world's food shortages could easily be overcome, so vast is the variety of food forms available to man. From the tiny one-celled algae and bacteria to creatures like cockroaches, locusts and gargantuan whales, all is grist to man's mill But as food forecasters and food technologists point out, what is available (and good for you) is not always eaten.

A "vegetarian" example illustrates this point better mankind has an estimated 80,000 species of edible plants at its command. But we have historically used no more than 3,000 for food Furthermore, 95 per cent of all calories and proteins consumed come from just 30 species.

This concentration on so few varieties is both unwise and dangerous, warn some botanists However, the "problems" of substituting say, an avocado with amaranth, are insignificant when compared to the problem of replacing hamburgers with wormburgers. The cultural prejudices involved are considerable (some experts say, insurmountable).

Despite all the squeamishness, however, several contests for recipes using earthworms have been held in Canada and the US. Indeed the Philippine Earthworm Centre "strongly recommends" spaghetti a la worms and wonton (dumplings) made up from worm mince. "Even if you don't eat the worms there is still money in them. Don't let the opportunity wriggle out of your hand," says Wenceslao Winsons Tan, owner of the only earthworm farm, "Wormery World," in San Juan, Manila. Tan's work with worms is attracting a lot of attention from farmers and importers particularly from Japan, Thailand and Cuba.

More important, worm meat has higher levels of "essential amino acids"—protein building blocks which the bodies of some animals (including man) cannot make themselves and so must get from their diet. Two examples will suffice: the amount of *arginine* in worm meat proteins is double that of peanut protein's and three times the percentage in anchovies. Similarly, tryptophane comprises 4.41 per cent of earthworm protein, making it four times as plentiful as in blood meal protein and seven times as much in protein from beef liver.

Millions of worms sleep soundly in 4,000 boxes measuring 2 ft by 1½ ft in Tan's dimly-lit warehouse from where he wants to saturate the Philippines with the creatures. A ready-made kit consisting of certified (oh yes!) prime red earthworm breeders plus the know-how to technology is sold at P750 (less than US $100) to anyone who wants to raise earthworms for livestock consumption or for export.

Tan claims he has no strings attached in departing with his own hard-earned technology except that he requires the breeders to sell the propagated worms back to him to market overseas. The problem is that no one wants to sell to him because Filipino farmers and livestock raisers have discovered earthworms can be a useful product, they can use themselves.

Apart from being used as feed for fish, hogs, poultry or dogs and cats, worms are still used as medicines and fertilisers. They are also useful in waste

composting since they eat virtually any organic garbage. And the Japanese have thought of a typically Japanese way to use them - they put them in hot sake, allowing them to secrete a milky liquid and then drink the potent brew. They consider it as an aphrodisiac additive to sake--their red wine.

Vermiculture came to Tan a decade ago by accident. He was asked and later pestered by the Japanese, to supply them with worms for fish and baits. He guessed worms were all there for the picking or rather for digging in the garden plot. He dug and dug and dug and to his utter amazement found no earthworms of commercial quantities for export.

He then took to study earthworm pretty seriously and from interest it became hobby and thereafter way of livelihood.

Dried worms contain 70 per cent crude protein, higher than that of fish-meal (65%), meat and bone-meal (50%), or soyabean (45%). It has a gross energy of 3,900 - 4,100 calories per kilo. In Taiwan, ducks fed on earthworms lay 30 per cent more eggs. And in Philippines, Tan discovered that earthworms can have great potential to improve mushroom cultivation and as anti-fever antibiotics.

After becoming convinced of the profit potential, Tan launched his earthworm business three years ago, nevertheless, since the idea of raising earthworms was repugnant to most people, he also organised the Earthworm Growers Association to promote the idea.

The impact of vermiculture is huge. Earthworms double their numbers every four to five days. With very little investment the small entrepreneur could earn upto. 15,000 Rs year.

In the package of technology, the Philippine Earthworm Centre distributes, the worm raiser gets a box of breeder with special fermented breedings made of sawdust, rice husks and rice bran. A pamphlet "How to raise earthworm" is distributed with each kit and Tan stresses he does not demand royalties or obligations.

The only catch is that the novice breeder must sell his produce to him for export.

Now the demand for domestic consumption among Filippine farmers has grown so rapidly that Tan is still not ready for export business. The home-grown earthworms are now increasingly being used to feed bullfrogs, cocks, fish, shrimps and eels.

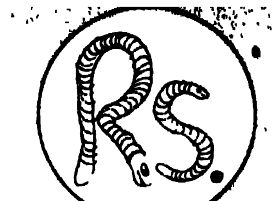
The spin off is vermi-composting. Since the earthworms feed on anything organic there is hardly any costs involved in raising them.

According to the National Taiwan University, 20 million earthworms can handle 80 tonnes of pulp sludge daily. Frank Carmody, an American authority on vermiculture claims that decomposting by earthworms is done in seven weeks compared to seven years if dumped in sanitary landfill. Thereafter the castings of the earthworms are used as fertiliser. They are, in fact, better than any organic fertiliser, currently available in terms of crop yield. A University of Oregon study has shown that earthworms castings are comparable to some chemical fertilisers. It is estimated that 1,000 tonnes of organic waste can be converted into 300 tons of organic fertiliser. Ramon Magsaysay Award-winner Phon Sang Sing Keo of Thailand, has gone into earthworm breeding from worms supplied by the Philippine Earthworm Centre.

Last year Tan sent five kg on request to Cuban President Fidel Castro reportedly for vermi-culture. Meanwhile, he tries to interest the unadventurous to sample the goodness of earthworms. He willingly serves you a meal of earthworms disguised as wonton, Spaghetti or a kind of pretzel. For gourmets many hotels in Philippines feature two delicacies: Vermiburger and Vermiloaf. Happy worming!

Sudhir Ghatnekar

Dr Ghatnekar is a biotechnologist stationed in Bombay.



Sons of the soil

IN the search for a fortune from worms, India is not far behind. At a Biotechnology Department at Ambarnath, Bombay, work continues on various aspects of earthworm farming such as the development of efficient earthworm strains, their genotype environment and on utilising them as "live tractors", fertiliser, and on feeding trials to fishes and ducks. In fine, the best method of using the worms. There are four earthworm boxes of 1.2 × .75 × .35 mt filled up with a mixture of dry grass weeds, compost, cow dung and soil in 10 : 20 : 30 : 40 proportion. Cultures of earthworm procured from local sources are inoculated. To accelerate growth horse gram powder is sprinkled at 50 gms per week. To prevent the escape of tiny worms the box is lined with waste polythene sheets. So far two strains have been found suitable to our environment the red worm *Lumbricus rubellus* and the manure worm *Helodrilus foetida*. In each of these culture bank more than 10,000 earthworms are constantly at their work. Our experiments prove that they double in number every four-five days. Experiments also proved that foliage of leucaena plantations increased at least one and half times in a plot "fertilized" with handful of earthworms at the base of each plant, relative to a control plot.

Therefore, earthworms are introduced now in various plots to optimise the biomass growth. Their introduction in the compost bin resulted in the acceleration of composting process too.

Trials also continue on using earthworms as feed for monoculture as well as polyculture systems of Tilapia and Carps with respect to control. Likewise their addition at 15 per cent level in ducks' diet everyday was found beneficial in egg laying capacity.

There was 25 per cent weight increase of Tilapia in a monoculture system by adding earthworm meal at 40 per cent level relative to control batch in 4 months period. Experiments on the polyculture system of Carps and Tilapias at 20-40 per cent level of earthworm meal continue in the plastic pool and pond with respect to control.

All these studies will reveal the important data which are later to be translated on a fairly large scale for our energy plantations programme. S.G.

STOP—YOU DON'T NEED THAT VITAMIN PILL

Hello, what brings you here today?

Doctor, I have been feeling dull and listless for some time And, though I do not know much about vitamins, I was thinking of taking vitamin tablets to pep me up. Can you please tell me something about vitamins?

Vitamins are naturally occurring chemicals present in minute amounts in virtually every item of our diet Yet, deprived of these tiny amounts, thousands of biochemical processes in cells all over the body would grind to a halt In fact, a person absolutely starved of vitamins cannot live long. No wonder pioneering scientists called these substances 'vital amines', from which the modern-day term "vitamins' is coined!

What 'vital' functions do vitamins perform?

While all vitamins are necessary for the normal growth of the body, each is responsible for the smooth functioning of a specific tissue or an organ in the body. Thus, vitamin A is required by the eyes to manufacture rhodopsin, a chemical needed for good vision. Lack of vitamin A causes xerophthalmia (drying of eyes), night blindness, and finally, total blindness. Vitamin D, together with calcium, is necessary for the growth of healthy teeth and bones. Rickets, a disease caused by vitamin D deficiency in growing children, is characterised by softened, deformed bones and teeth Vitamin K is essential for the normal clotting of blood that occurs when a vessel is damaged, and without it, the tiniest injury can lead to severe bleeding.

And, what about the B complex vitamins?

Of the B complex vitamins, B1 (thiamine) helps produce the energy needed for the daily wear and tear of cells, especially those in the heart, nerves and brain Heart failure, nerve and brain damage occur in beri-beri, a disease caused by thiamine deficiency Two other B vitamins, B9 (folic acid) and B12 (cobalamin) are used mainly by the bone marrow to produce red blood cells. Their deficiency leads to a disease called megaloblastic anemia, in which the normal dumb-bell shaped red blood cells become large, pale spheres incapable of transporting enough oxygen from lungs to tissues.

Doctor, what about the miracle cures of vitamin C?

Vitamin C is needed by the body to prepare a substance that plugs tiny 'holes' in the walls of blood vessels It also binds together cells in various tissues Scurvy, a disease known since ancient times, is caused by a severe lack of this vitamin and is manifested by spongy gums that bleed at the slightest trauma and bleeding from other sites in the body as well.

Is it true that vitamin C prevents the common cold?

A number of medical authorities, including the internationally acclaimed Nobel laureate Dr Linus Pauling — who, incidentally, pioneered the use of vitamin C in treating the common cold — believe that the vitamin does prevent the ailment. However, this claim is controversial. Dr Pauling recommends as much as a few grams of vitamin C, and some experts say that the chronic use of such large doses of vitamin C may be harmful At any rate, the many cold 'remedies' flooding the market contain at the most, a few hundred milligrams of vitamin C and are of dubious value. Of course, the final word on vitamin C and the common cold has still to be said. Till then, the cliche "If you treat a common cold, it lasts for a week; if you don't do anything for it, it lasts seven days!" still holds true.

What must we do to get enough of each vitamin?

Intake of a mixed diet is the best way of providing your body with adequate amounts of all the vitamins Green leafy vegetables, extremely rich in vitamin A, contain almost every vitamin except D. Other vegetables such as carrots and pumpkins, as well as fruits like mangoes, jackfruit and papayas can also give you a lot of vitamin A. For B vitamins, especially thiamine, cereals, pulses, nuts and oilseeds are the best. For vitamins A and D, there is nothing better than fish liver oil. Meat and eggs too provide large amounts of both these vitamins Milk is a good source of A, B and D, as well as C, but most of the C is destroyed by boiling To get enough of vitamin C, you must eat plenty of fruits like oranges, pineapples, guavas and *amla* Lime and tomato juice too have large amounts of vitamin C

Is food our only source of vitamins?

Strange as it may seem, food is not the only means of obtaining vitamins. This is especially true of vitamins D, K and B12, which are mainly found in foods of animal origin The ultra violet rays of sunlight act on a chemical already present in the outer layer of the skin, and transform it into vitamin D. Certain micro-organisms that live harmlessly in our intestines themselves produce vitamin K and B12. Though the amounts produced are tiny, they are quite sufficient to fulfil the body's needs once they are absorbed into the bloodstream. In fact, were it not for the body's own sources of production, pure vegetarians might have suffered from a deficiency of these vitamins!

Is it true that processing reduces the vitamin levels in foods?

Yes. For instance, foodgrains like wheat consist of an outer vitamin-rich part, the germ and bran, and an innermost starch-laden core, the endosperm. Milling separates the bran and germ from the endosperm. While the nutritious bran and germ are usually converted into feeds for livestock or simply thrown away, the endosperm is processed into white wheat flour *(maida)*. White breed made from this *maida* is relatively poor in vitamin B. So are foods made from *rava*, another kind of wheat flour consisting almost entirely of the vitamin-poor endosperm Milled rice also loses much of its vitamin B during processing.

What is the effect of parboiling on the vitamin content of rice?

Parboiling is an old Indian method of processing rice that preserves most of its vitamin content. Paddy is first soaked in water, steamed and then dried It is then either milled or pounded at home before consumption. During the parboiling process, B vitamins from the outer layers of the grain get concentrated in the endosperm and subsequent milling does not affect it Thus parboiled milled rice is a richer source of vitamin B than raw milled rice.

Can washing and cooking adversely affect the vitamin content of foods?

Yes positively. For instance, many Indian housewives wash and cook rice in water, which is then thrown away. This water is rich in B vitamins. Home pounded or milled parboiled rice is not drained of its vitamin content to the same extent by cooking in this manner. Pressure cookers too minimise the vitamin loss. Otherwise, as much as 20 to 50 per cent of thiamine

Think hard before popping a vitamin capsule into your mouth. You don't need it if you are on a well balanced diet

may be lost in the cooking water. A lot of vitamin C can also be lost in this way.

Secondly, addition of other substances may be harmful. For example, addition of cooking soda to legumes *(dal, white chanas)* to improve their flavour, actually destroys much of their vitamin B value. Vitamins A and D are not affected by such cooking practices, but excessive frying or roasting may lead to their reduction on many foods

Are fermentation and germination good cooking practices?

Yes Fermentation of dough, yet another Indian custom used in the preparation of foods like *idlis, dhoklas* and *dosas*, actually increases the content of B and C vitamins in these food items. Germination too has a similar effect and dishes prepared from germinated pulses, such as *usal*, etc. are rich in these vitamins

Can the vitamin loss from foods be minimised?

Of course The longer a foodstuff is heated, and the larger the amount of water it is boiled in, the greater is the loss of B and C vitamins from it Therefore, to prevent this, all you have to do is use as little water as possible in cooking, and try and avoid direct contact between the food and cooking water. Steam cooking, commonly used for foods like *idlis*, easily achieves this. Pressure cooking too helps in the same way To best preserve the vitamin content of vegetables, they should be washed, peeled if necessary, cut into a few large pieces and then immediately added to boiling water Prolonged boiling must be avoided to prevent loss of B and C vitamins Prolonged cooking of foods of animal origin, also reduces their A and D content

Do we need to take vitamin tablets to correct this loss from food processing?

Absolutely not The loss of vitamins through processing is usually more than compensated for by the quantity and variety of foodstuffs we consume In fact, so widespread is the distribution of vitamins in all natural foods, and so microscopic our daily requirements that no one eating sufficient amounts of a well-balanced diet can suffer from a vitamin deficiency

Then why is vitamin deficiency so common among Indians?

Obviously, poverty, which forces many to consume less than adequate amounts of food, is an important reason More important, however, are ignorance and faulty food habits. For instance, thousands of Indian children are not weaned at around three to six months of age, as they should be, but are breast-fed for a prolonged period of time. Breast-milk alone will not do for these growing infants. They are thus not given solid foods till they are much older, and this can set the stage for protein, calorie and vitamin deficiency.

Older children are just not given enough nutritious foodstuffs, like green leafy vegetables and fruits. Many ignorant parents are lured by the tall claims made by a variety of food powders and drinks, and feed their children with these products which they cannot really afford. Expensive 'tonics' are no good either because they contain too minute amounts of nutrients to help malnourished persons

Does vitamin deficiency result only from inadequate food intake?

No. Occasionally, faulty absorption or faulty utilisation by the body itself may give rise to vitamin imbalance, which is termed a conditioned vitamin deficiency For example, in diarrhoeas and diseases caused by damage to the delicate inner lining of the gut, absorption of almost all nutrients, including vitamins, is affected. Certain drugs, too may cause such a vitamin deficiency Prolonged oral use of antibiotics destroys the micro-organisms in the intestines, cutting off the vitamins they supply Or, excessive consumption by the body itself, as in fevers, may set the stage for deficiency of certain vitamins.

Diseases of the liver and biliary system can also produce such a conditioned vitamin deficiency, especially of A, D and K. These vitamins require bile for their absorption and any defect that prevents sufficient quantities of bile from entering the intestine will seriously interfere with their uptake by the body. The liver also helps to convert many vitamins into a form suitable for use by different tissues of the body. Therefore a person suffering from a liver disease may develop a vitamin deficiency in spite of eating sufficient amounts of food.

So only persons suffering from such conditions need to take extra doses of vitamins?

Exactly, and that too under a doctor's supervision and if the basic cause responsible cannot be corrected. For thousands of others who consume proper diets, vitamin preparations are a sheer waste of money. That's because all B vitamins, as well as C, are soluble in water Therefore, after your body's miniscule quota of these vitamins is absorbed, the excess is simply voided in the urine So its no use popping in pills containing 10, 20, occasionally even 50, times more vitamin B than you actually need Your money quite literally, goes down the drain'

Do A and D supplements also get flushed out of the body in this manner?

No, unlike the B and C vitamins, excess amounts of vitamins A, D and K cannot be excreted via the urine They can only be eliminated through the bile, and thence,

ILLUSTRATED BY FRANCIS H DSA

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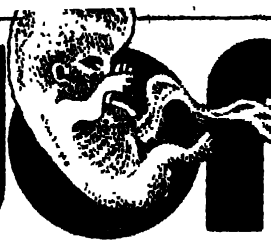


PROBING THE WOMB

Amniocentesis probes into the privacy of the womb and reveals genetic diseases and the sex of the baby

THE prenatal clinic was crowded with mothers-to-be, young as well as not so young. Anxiety was writ large on Sumitra, aged 36, who was a mother of a mentally retarded (Mongol) child It would be horrifying to bear another Mongol baby. She was completely aware that with advancing age, the chances of her having a normal baby decreased considerably. But, a normal baby she must have. However, the fear of having an abnormal or a deformed child was uppermost in her mind and hence the visit to the clinic.

Sumitra will now have to undergo 'amniocentesis' in order to know whether the child she is carrying is perfectly normal.

Amita had been to the doctor for a prenatal check-up before. But, this was different This was her fourth child, the other three being girls. A great tension built up inside her She remembered the doctor's comforting remarks about the whole procedure being painless The doctor was just going to collect some fluid from her four-month pregnant tummy and let her know the sex of the coming child within a few days What if again she got a baby girl?

The above two instances bring out the different approaches being adopted by people in the use of this technique Amniocentesis is proving to be a powerful technique in the hands of scientists for the detection of genetic abnormalities in the unborn babies. It is another story altogether that the parents especially in India are using this technique for the determination of the sex of the baby This practice should be discouraged as it can be misused too by the people In the male-dominated (Indian) society, where the desire for a male child is rather comical, if not hysterical, and there is a premium for a male child, the technique may be used to abort female foetuses in an unresponsible manner. This does not only go against the medical ethics but can also have serious societal implications of drastically upsetting the natural male-female ratio.

Sex determination

But, how is the sex of the foetus determined in the first place? Sex of a child is determined at the moment of conception by a chromosomal mechanism Each cell of the human body has 46 chromosomes. These chromosomes occur in pairs and we

Sample removal of the amniotic fluid

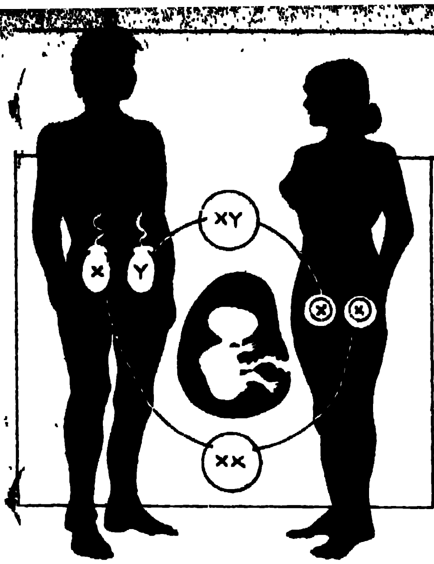
have 23 pairs Of these, 22 pairs are similar in both man and woman. Only one pair is different These are known as the "sex chromosomes" The woman has a matching pair of sex chromosomes, XX. In the man, one of the pair is homologous to the X chromosome but the other, the Y chromosome, is quite different in shape, size and its genetic constitution Therefore, the sex chromosomes in a man can be denoted by XY and in the woman as XX

A fertilised egg may develop into a male or female depending on whether its chromosomal constitution is XX or XY The sex of an individual is thus determined by the chromosome contributed by the male partner In other words, it is the father who is solely responsible for the sex of the child. [Mothers-in-law and husbands to take note.]

According to a convention universally followed by cytogenecists, chromosomes are studied by them in groups according to their length and the position of the centromere (the constricted region at which the chromosomes are held together). The groups of chromosomes are then designated by letters and the individual pairs identified by numbers 1 to 22 plus XX or XY This array of chromosomes is known as the "karyotype", and all living species, plants or animals, exhibit a variable karyotype Normally, the karyotype remains constant in an organism. However, changes can occur in the number or the arrangement of the chromosomes, upsetting the normal karyotypic pattern These changes are reflected in the overall genetic make-up of an individual An individual can have certain abnormalities associated with these chromosomal changes But, a normal karyotype does not exclude an abnormality of the foetus.

Let us have a look at some of these abnormalities The cells in the females have a dark-staining body known as the 'sex-chromatin' or 'Barr body' in the nuclear membrane Barr-body is absent or infrequent in cells of males Certain men who have sex-chromatin or are sex-chromatin positive are known to have poorly developed testes and have a female body-build. They show Klinefelter's syndrome Chromosome studies show that these men have 47 chromosomes instead of 46, and have three sex chromosomes, XXY Similarly, women show Turner's syndrome when they are sex chromatin negative and have poorly developed gonads and webbed neck These women have 45 chromosomes with only one sex chromosome, X Mongolism in

Arrangement of chromosomes according to their shape and size in normal male



Sex determination

children is also another form of chromosomal disorder. Mongols have 47 chromosomes, the extra one being number 21. Besides these numerical abnormalities of the chromosomes, there are various structural abnormalities involving deletions of a chromosome segment or its translocation to the same or different chromosomes, as in the case of Mongol children.

These abnormalities are detected once the child is born. However, the parents and the society can escape the trauma of looking after these abnormal or physiologically deficient individuals, if somehow the diagnosis can be predicted at an early stage. This is now possible with amniocentesis.

Amniocentesis

In India, genetic counselling as a folk practice has existed for centuries. However, prenatal diagnosis has begun to revolutionise genetic counselling. Amniocentesis is one of the best methods to diagnose the chromosomal disorders, besides indicating whether the foetus is a 'he' or a 'she'. From Greek words meaning "puncture" and "amnion" (the sac enclosing the foetus within the uterus), amniocentesis has emerged as a boon to the expecting parents. The procedure consists of inserting a sharp three-inch needle attached to a syringe, through the abdominal wall into the uterus and removing a small amount of the amniotic fluid. Usually amniocentesis is carried out following ultrasonography or 'echo sounding" which locates the placenta by means of sound waves.

The collected amniotic fluid mainly consists of urine and cells sloughed off from skin, respiratory and urinary tracts of the foetus. This fluid is then centrifuged or spinned to settle the foetal cells which are then seeded into the flat surface flasks of culture medium where they are allowed to grow for about two weeks. The cultured cells are processed further for karyotyping and enzyme assays. In this way, before the birth of a baby, its cytogenetic profile, including its sex (XX or XY) is determined.

Understandably, this technique has found great use in the detection of at least sixty "inborn errors of metabolism", or genetic abnormalities due to certain enzyme deficiencies, besides diagnosing chromosomal disorders. The cells in the fluid are tested to diagnose Down's syndrome (mental retardation), and galactosemia (inability to metabolise sugar). Also, high levels of alphafetoprotein (AFP) in the amniotic fluid would mean that the foetus may be afflicted with malformations, like anencephaly and spina bifida or neural tube defects like Tay-Sachs disease. This AFP is manufactured in the liver of the foetus which is then passed into the amniotic fluid when the foetus urinates.

A Mongol child

The technique works well in experienced hands and is reasonably safe. There is, of course, a slight risk of inducing spontaneous abortion (1 in 100). Injuries to the foetus, for example, needle punctures, is more common. About four to six foetal injuries among 200 women have been reported. Also, British studies have revealed a small risk of congenital orthopaedic defects like club-foot and premature birth, occasionally with foetal respiratory problems. These risks, perhaps, occur in one or two cases out of 200.

To be safe, the doctors remove the amniotic fluid around 14 weeks of pregnancy after the last menstrual period. The tests take another two weeks. If any abnormality is noticed, the termination of pregnancy is suggested to the parents. The removal of the fluid later than 14 weeks is not advisable as the movements of the foetus start by around 16 weeks. At this point, therapeutic abortion becomes more psychologically distressing for the mother—she has started 'feeling life' within her. At the same time the test cannot be undertaken before 14 weeks of pregnancy since then the quantity of amniotic fluid bathing the incompletely formed baby, is inadequate for the test to be carried out.

The decision to terminate pregnancy, in case of an abnormal baby, depends on several factors like the age of the mother and the number of children she has. Perhaps, an elderly couple in forties with 'no issue' yet, may still go ahead with the baby, which may not be true for a young couple. The mental make-up of the couple is another important factor to take into consideration.

Genetic counsellors generally suggest prenatal diagnosis for mothers of advanced age (over 35 to 40 years) or for parents carrying chromosomal translocations or for mothers who have been exposed to radiation during the early stage of pregnancy. The question still remains as to who should be offered amniocentesis. It must not be done to satisfy mere curiosity. Amniocentesis must be done with some end in view. That end is the abortion of the would be deformed child. Although one cannot deny that termination of pregnancy is taking a human life, a defective foetus may end up as an unwanted child and a burden to society.

Parul R. Sheth

Dr (Mrs) Sheth is on the editorial staff of SCIENCE TODAY. She was formerly with the Institute for Research in Reproduction, Bombay.

Chorion Biopsy

PRENATAL diagnosis is carried out during the second trimester of pregnancy. This is the critical time when the risk to the woman who faces abortion heightens. Recently, an extraordinary procedure for testing the foetus in the initial 12 weeks, or in the first trimester was tried out. The technique is known as 'chorion biopsy'. It consists of collection of a small fragment of tissue (biopsy) from the trophoblast, the outermost layer of the chorion which surrounds the amniotic envelope that encloses the foetus. This tissue is not a part of the foetus, but is derived from the fertilised egg and is therefore genetically identical to it. The biopsy is done by inserting a catheter guided by an ultra-sound scan, through the cervix, into the uterus. The biopsy material thus consists of a part of chorion from which tiny thread-like projections (villi) protrude. The scientists then examined the DNA directly in these projections, thereby diagnosing every genetic condition.

The chorion biopsy technique has mainly two advantages over the amniocentesis technique. Firstly, the detection or diagnosis can be made as early as 12 weeks and secondly, the biopsy does not involve the puncture of the amnion as in the case of amniocentesis. However, the safety and accuracy of the technique is yet to be assessed. But, should it prove reliable and safe, it will revolutionise prenatal diagnosis.

P. R. S.

FUSION RESEARCH IN INDIA

P. K. Kaw   P. I. John

INDIAN efforts in high temperature plasma research have been nil, except for a brief foray into toroidal pinch studies at the Tata Institute of Fundamental Research (TIFR), Bombay, during 1956-68. Reflecting the declining fortunes of fusion research over the world, this programme was terminated in 1968. Dr. Vikram Sarabhai picked up the threads again when he, with his characteristic vision, decided to start a plasma research programme at the Physical Research Laboratory (PRL) in Ahmedabad. Thus the early 1970s saw the birth of a systematic programme of theoretical and experimental studies in plasma physics at the PRL. Around this time, the Bhabha Atomic Research Centre (BARC), Bombay, also initiated work on plasma studies based on lasers

The PRL studies have addressed a variety of basic phenomena in a wide range of parameter space. One of the significant discoveries dealt with the behaviour of rarefied electron clouds in a magnetic mirror. This experiment revealed that the initial uniform distribution of electrons, in their orbit around the magnetic lines of force, very soon formed clumps due to the fast loss of particles from some regions of the orbit from the trap. In another experiment to understand the interaction of fast plasma streams with clouds of neutral gas—simulation in the laboratory of the situation in space when a comet encounters the wind of solar plasma—it was found that large electric fields develop in the region separating the plasma from the gas, and this electric field then heats electrons to temperatures of the order of a million degrees centigrade. Other experiments were performed to study the interaction between plasma and beams of electrons carrying billions of watts of power. These experiments have helped understand how the energy in the beam is used in heating the plasma.

A turning point for high temperature plasma research in the country came when the Department of Science and Technology identified plasma physics as a high priority area in the Sixth Plan projections and proposed to intensify research in this area. A programme on the study of magnetically confined hot plasmas has been initiated at Ahmedabad. A major element of the programme is the construction of a low-field high-volume tokamak and the investigation of certain unexplored areas of tokamak physics. For example, it is well known that the conventional tokamak discharges— those which are directed towards fusion studies—operate only in a very limited parameter space. Accessibility of this parameter space is largely determined by the start-up phase of a tokamak discharge and a variety of external parameters such as injection of neutral gas and plasma wall interaction. All these are still poorly understood For example, one still lacks a quantitative understanding of plasma production and sustainment by a variety of energy sources. The experiments planned will exclusively seek answers to these questions.

Another area of research is the so-called unconventional modes of tokamak operation. As an example, recent results indicate that a tokamak in which a substantial part of the toroidal current is carried by high energy electrons tends to have better energy confinement properties. These regimes which are of basic interest in

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O[illegible] together to constitute the Plasma Physics Programme, presently stationed at the Physical Research Laboratory, Ahmedabad, will build "Aditya", a tokamak—the most successful and popular fusion machine to date. Aditya will reproduce some of the reactions that occur at the Sun's core. Under controlled laboratory conditions, a temperature of 5-10 million degrees will be reached.

The Government of India in its Sixth Five-Year Plan has declared fusion to be a "high priority" research area, and therefore will fund fusion at a level well enough to enable India to "leap-frog" into the future. So far, only a few of the most advanced Western countries have undertaken fusion research.

The Government's investment in fusion on a large scale is a new phenomenon in India. However, plasma physics (the physics of extremely high temperatures) research is not completely new to India. Dr. Vikram Sarabhai had envisioned the importance of plasma physics in the sixties. He considered plasma physics to be an integral component of any space science programme and set out to create a nucleus of plasma physicists at the Physical Research Laboratory (PRL) On his invitation, several young scientists, including Predhiman Kaw, working at Princeton University, USA, joined the PRL Just four months after the group's initiation, Sarabhai died. Without his backing, support for fusion became uncertain. The group lost some of its members, including Kaw, and plasma physics in PRL continued on a shoe-string budget.

While the Indian plasma physics effort was diffused, exciting developments were underway in the international fusion scene. The mid and late seventies were landmark years in the history of fusion. The Alcator-C Tokamak at the Massachusetts Institute of Technology demonstrated that it was possible to confine very high density plasma of a relatively pure grade and it established empirical scaling laws which augered well for reactor-size devices. This success was followed by the Princeton Large Torus device achieving very high temperatures by the injection of high energy neutral particles. These spectacular and complementary achievements were widely acclaimed.

Kaw, Swadesh Mahajan and A. Sen. Indian plasma physicists abroad, were caught up in the excitement of the times. They frequently met to discuss the initiation of a largescale fusion programme in India. They contacted other scientists and discovered that their project generated a lot of interest and

[illegible] INDIAN SUN?

[illegible] physicists pledged to [illegible] programme. In 1978, they [illegible] proposal to Dr. Atmaram, [illegible] Chief Adviser to the Government for Science and Technology. Dr. Atmaram expressed his interest.

Given this initial positive response, the scientists abroad, together with a [illegible] physicists at the PRL, including Dr. John, who constituted the core group, developed an organisational model for their programme. They decided to nurture their project at PRL, using the core group of scientists there as a nucleus. While at PRL, they would work towards becoming an autonomous body.

The change of government in 1979 required that the initial proposal be resubmitted. Prof. D. Lal, then Director of the PRL, wrote to Prof. M. G. K. Menon, then Secretary in the Department of Science and Technology (DST), in support of the Plasma Physics Programme (PPP) proposal. Prof. Menon was encouraging, but urged the group not to commit themselves to the narrow goal of obtaining nuclear fusion. He suggested that they broaden their base to include basic plasma physics research. A scientific committee was established to study the amended proposal. A national consensus was reached that the PPP would complement the activities of the Atomic Energy Commission (AEC). While the PPP was to pioneer magnetic fusion, the AEC was to conduct inertial fusion activities.

The proposal made by the plasma physics team was attractive to planners because it provided a new model for scientific expansion. The project was unusual in that the initiative came from physicists. And it complied with the policy directives of the DST.

In the design of Aditya, PPP scientists have to work within the constraints of Indian technology. The goal is to study plasmas at extremely high temperatures and basic physics properties of the device. The realisation of such goals demands sophisticated engineering such as high vacuum power systems, high magnetic fields and large currents for very short periods of time, and mechanical support structures that can sustain the accompanying stresses. The PPP is collaborating with Tata Consulting Engineers (TCE) and the Bhabha Atomic Research Centre (BARC) in the engineering construction of the device; the Programme will thus help expand engineering frontiers in such areas as [illegible]

[illegible] this intricate [illegible] in time.

Apart from Aditya, there are some smaller experiments which will study basic issues. A few are already functional and have produced some interesting results. One is a Compact Torus experiment that examines physics issues relating to an alternative concept in magnetic fusion. Another experiment, known as Beta (acronym for Basic Experiment in Toroidal Plasmas) is somewhat larger. Beta should be operational by next year.

A problem that PPP faces lies in the area of recruitment. Because India does not have an established tradition of fusion research, the actual number of people trained in fusion physics are few and far between. Therefore, out of necessity, the programme must look to people in related disciplines. Not many established scientists are willing to move into completely new fields of research. It has been easier to attract younger scientists who are willing to risk the transition. Many experienced people that the PPP wished to acquire held responsible and well-paid positions in the US. To attract them scientific incentives have to be offered which will override the financial disparities. So far, the PPP has succeeded in bringing back five scientists.

Dr. Kaw explains that scientifically the programme is "challenging" and attractive for those returning from the US "because pressures differ considerably in the US and India. In the US, plasma physicists must further a certain parameter space. Here we have a very broad mandate—to generate a programme which does basic physics with high temperature magnetically confined plasma. Our emphasis will be on basic plasma physics issues which have not yet been resolved".

The major experimental effort in plasma physics in the US is conducted in large national laboratories. Plasma physicists are under tremendous political pressure to demonstrate the viability of fusion. They must rely on Congress to renew their contracts, and Congress is, by the nature of the political process, very result-oriented. Thus sometimes scientists are impelled to attain quick results, at the expense of resolving some basic physics issues. Since the Indian Government is interested in funding basic physics research, the Indian team [illegible] with somewhat long-term and [illegible] problems. It is in this area that the new group can make an important contribution. However, in the view of some skeptics, fusion physics, though young, is a mature field in which striking discoveries have become more the exception than the rule. Almost any concept of promise, they feel, has been seriously studied. This leaves pockets rather than open spaces, in which a new and small group like the PPP can expect to make contributions.

Among the team, there is optimism and excitement. Meanwhile, plans for a new campus are underway. The Government of Gujarat has donated the programme 50 acres of land in Bhat on the Gandhinagar highway. The campus is to be ready by 1985.

Since the advent of the PPP, two other institutions have undertaken to do fusion research. The Saha Institute of Nuclear Physics in Calcutta is building a tokamak with Japanese and American collaboration, which is planned to come on line in 1985. The BARC will have an intertial fusion programme at the Centre for Advanced Technologies being set up at Indore.

Extrapolating from the empirical scaling known to date, fusion is almost an unaffordable technology, even by western standards. Research is underway to make fusion technologically viable. Alternative concepts are being explored to produce fusion energy more economically. It is certainly valid to question if India should invest in fusion research. The answer is complex, for it critically depends on developments in an area of science which still has many unknowns. So far, as India's science budget reveals, we have opted for high technology despite costs. Therefore, investing in plasma physics is not inconsistent with our scientific policy.

Undoubtedly there are some benefits to be obtained by investing in fusion research. First and foremost, if fusion proves to be technologically viable, India will be in a position to reap its benefits. The field is interdisciplinary in character; therefore consolidating work in this area may contribute towards building a framework for applied science research in India. Furthermore, by working closely with Indian engineers in the building of their sophisticated devices, the frontiers of technology are being pushed forward. If the planners can capitalise on these developments imaginatively, there is scope for "spin-offs" from fusion.

Joel Silliman

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COURTESY K V SARABI

The BETA *device, completed in December 1983, will form a magnetic cage with the help of very high energy electron beams injected into a toroidal magnetic field*

understanding tokamak physics have been left out in the cold because of the fact that most of the tokamak experiments are directed towards higher temperature, better nt values, etc. Apart from the tokamak experiment, the programme also plans to study some alternative magnetic confinement schemes. Compact torus formation with high currents excited in a plasma by an intense beam of spiralling electrons is one such experiment. In another, electron beams would be injected into a small toroidal device and the resulting magnetic configuration would be used to trap and confine plasmas.

Scientific groups at the BARC are also planning high density plasma experiments using lasers and intense particle beams as drivers. A four-beam short-wave length (1.06 microns) laser which will deposit a terrawatt power on a D-T-filled glass microballoon target is proposed to be built to undertake investigations in laser plasma interaction, compression and related studies. Plasma temperature upto 5 million degrees and a neutron production of 10 per pulse is expected. Particle beam sources - both electron and light ions in the kilojoule energy range - are also proposed for development. Devices for production of high density pinch plasmas are being designed for operation with a 500 kilojoule energy storage bank for experiments in neutron radiography and on studies on the effect of fusion reactor environments on various materials. Preliminary studies on using the fusion neutron bursts from their devices for breeding fissile fuel from thorium are also planned.

Many perspectives are possible on fusion research. As a field of physics, it has expanded the horizons of our understanding of matter at extreme temperatures. As a technology, it has motivated remarkable developments in new materials, strange magnetic configurations, and intense particle and radiation sources. As a future energy source, it holds unlimited promise.

The most relevant and valid perspective is that fusion plasma physics is still at a stage where its pursuit can hold the promise of fundamental knowledge. Being one of the simplest many-body systems, a plasma can make rich contributions to the physics of co-operative phenomena, nonlinear and stochastic processes, thermodynamic and statistical mechanics of irreversible systems, etc. The understanding of the evolution of collective plasma modes which extract various forms of free energy and grow into saturated nonlinear states (which may be either turbulent or coherent) is crucial to a clearer perception of various basic plasma phenomena. The concept of 'solitons', a strongly interacting nonlinear entity which had its birth in the field of nonlinear equations applicable to plasmas, has invaded all areas of physics (elementary particle theory, physics of macromolecules, solid state physics, to name a few). Studies of plasma turbulence form part of a quest that physicists have been pursuing to understand the origin of stochasticity in deterministic systems.

The unique feature of the research in high temperature plasmas is that even these basic studies would demand plasmas of large size and high parameter range. This requirement comes simply because of the necessity to avoid wall and collisional effects characteristic of small, low-temperature devices. This is in fact a blessing since the investment in building such devices for basic studies will spur the development of diagnostics and other fusion technologies and can be of great value for the future.

The long-term perspective must take into account the reality of international competitiveness when fusion enters the realm of an economically viable energy technology. Past experience in international cooperation in other areas of technology—nuclear power, space, electronics, to name a few—teach us that without the development of indigenous expertise, we stand nowhere in the adaption of such technologies. Fusion energy technology is not expected to be an exception to this. It is not unreasonable to expect that the post-breakeven devices will enter the shadowy regime where access to information will be either restricted or will have a high price-tag. The building of such devices is not too far in the future, if currently available projections on fusion research programmes is any guide. If we are now ten years behind in essentially physics-oriented devices, what is the gap going to be in technology?

Drawing up a programme which combines both the scientific and technological facets of fusion research and which reflects a national commitment to make up for the lost years must have national priority.

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The first part of this article appeared last month

THE QUALITY OF EQUALITY

Prabha Srinivasen

ONE usually associates the word *isotope* with the clicking of the Geiger counter and not with the famous battle cry of the revolutionaries—equality, liberty and fraternity! However, *egalite* is related isotopy (radio-active or otherwise). For both revolve around the concept of *equality:* the root *iso* in Greek means equal and it occurs widely in scientific nomenclature. By the same token, *isolate* does not mean "equally late"! It is in fact derived from island and insulation. Given below are ten examples. Can you spot the *equalite* they represent?" Answers on pages 72, 73.

(1) Isotropic:
- (A) Regions in the same climatic zone.
- (B) Having identical properties in all directions.
- (C) Pressures applied equally on all sides.

(2) Isotonic:
- (A) Equally potent tonics.
- (B) Regimen producing uniform muscle tone.
- (C) Solutions of same osmotic pressure.

(3) Isoclinic:
- (A) Special ward for isolation of patients with a contagious disease.
- (B) Two points with identical degree of sterility.
- (C) Equal values of magnetic dip.

(4) Isosceles:
- (A) A triangle with all sides equal.
- (B) A triangle with all angles equal.
- (C) A triangle with two sides equal.

(5) Isobar:
- (A) Used in gymnastics.
- (B) A line connecting points of equal pressure on a meteorological chart.
- (C) Bar selling health drinks.

(6) Isodose:
- (A) Two points receiving equal radiation.
- (B) Stereochemically inert drugs.
- (C) Different medications in the same dose.

(7) Isochromatic:
- (A) Cell with all chromosomes of equal length.
- (B) Of same colour.
- (C) Alloys of equal concentration of chromuim.

(8) Isomers:
- (A) Of equivalent oceanic latitudes.
- (B) Chemical twins.
- (C) A substance in forms of varying atomic weights.

(9) Isothermal:
- (A) Malfunctioning in heating coils.
- (B) Without any change in heat.
- (C) Isolated from temperature differentials.

(10) Isometric:
- (A) Fragments derived from the same meteorite.
- (B) Of equal measure.
- (C) Of standard length.

CONSULTING ROOM

➔ *from page 39*

the stools, over a prolonged period of time. In fact, for those on normal diets, especially children, extra large doses of these vitamins may prove harmful by accumulating in the body. Of these, A and D are most dangerous, if you take too much of them, as they can cause diseases called 'hypervitaminoses'?

What happens in 'hypervitaminoses'?

Very high doses of vitamin A can lead to hair loss, cracked lips, loss of weight, enlargement of the liver and bone and joint pains. Excess vitamin D can denude your bones of calcium leading to dangerously high levels of this mineral in the blood and causing irreparable harm to the kidneys and other vital organs. Of course, such toxic effects are seen only when extremely large doses of vitamins A and D are consumed over a long period of time. Even so, no healthy person should take extra vitamin A if he eats enough yellow and green vegetables and fruits. Similarly, no one having a normal diet and getting adequate exposure to sunshine should take more vitamin D.

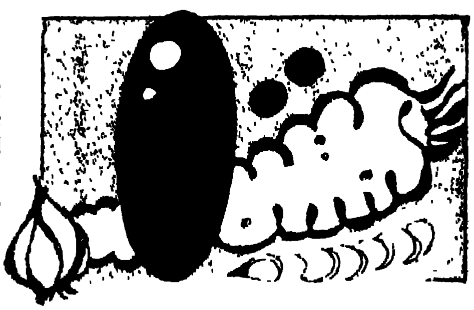
Besides curing diseases caused by their deficiency, do vitamins have any other use?

Certainly. They are drugs too and can be used in the treatment of certain other diseases as well, (besides vitamin A in night blindness, thiamine in beri-beri, vitamin C in scurvy and vitamin D in rickets). These include vitamin C in a disease called methemoglobinaemia (in which haemoglobin, the red coloured pigment of blood is replaced by an abnormal brown substance), vitamin D in some diseases of the parathyroid gland, and vitamin K in certain coagulation problems.

But swallowing synthetic vitamins in order to correct perfectly natural phenomena like 'mental strain' and 'tiredness', or to bring about 'increased growth' and 'extra energy' makes no sense. It is a dangerous half-truth to believe that if some thing is good, the more the better.

What about megavitamin therapy? Is it any good?

In the wake of Dr. Linus Pauling's boost for vitamin C, a large number of medical scientists, as well as pharmaceutical companies, jumped onto the megavitamin bandwagon, claiming that very large doses of vitamins (mainly the water soluble ones) could be a panacea for a number of ailments ranging from cancer to hypercholesterolaemia. These too are very controversial claims, not supported by repeated experimental study. In fact, a recent report in



a prestigious American medical journal described how one such megavitamin regime actually led to damaged nerves. Therefore, until rigorous scientific study of megavitamin therapy is carried out, it is safest not be subscribe to them

Many doctors routinely prescribe multivitamin preparations together with antibiotics. Is this really necessary?

No, unless the drug used is a broad spectrum antibiotic and is prescribed for a long period of time. Or, unless the patient cannot be relied upon to partake of his usual balanced diet during the illness.

Shivanand S. Karkal

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LEAD POLLUTION FROM AUTO EXHAUSTS

R. N. Khandekar

NO other chemical pollutant has accumulated in human beings to an average level so close to the threshold of potential poisoning as lead. And it is the children who are at maximum risk.

Though the battery industry is the biggest single user of lead (SCIENCE TODAY, June 1982), it is petrol-fuelled vehicles which contribute more than 90 per cent of the lead in the air in urban areas. Much interest has, therefore, recently been focussed on lead from automobile exhausts and there is general concern whether or not the levels of lead found in the environment today are safe.

The problem will now get worse as the octane number of petrol was raised from 83 to 87 in last September. For, most of this extra octanes will be obtained through the use of lead antiknocks. For instance, the use of 87 octane petrol will add about 12 per cent more lead to the air in Bombay and will increase the blood lead level of the Bombay population by 8 to 10 per cent within a short time. (Tetraethyl lead or tetramethyl lead is added to petrol as antiknock agent to increase its resistance to detonation or knock in spark-ignited engines; the octane number is a rating that indicates the tendency to knock.)

With the present rate of increase in the number of cars, 450 to 510 tonnes of lead will be released into the atmosphere in Bombay by the end of this decade, compared to 250 tonnes in 1979-80 and 300 tonnes last year. The uptake of lead from the atmosphere will consequently increase and the average blood lead level of Bombay residents is likely to go up from 16 to 18 microgrammes per 100 ml to 26 to 32 microgrammes per 100 ml of blood. This is an average value, which means an upper level of 64 microgrammes (assuming a log normal distribution), that is, nearly half the population in Bombay will exceed the tolerable blood lead level of 30 microgrammes per 100 ml. This suggests that immediate efforts have to be made to reduce the atmospheric lead level to avoid excessive exposure of the general population of Greater Bombay to lead.

In fact, the trend in all major cities in the world has been to reduce the lead in petrol while in India it has been increased. Japan, Canada and the USA have introduced lead-free petrol. In Tokyo, blood lead levels have fallen by 70 per cent since 1967 when lead-free petrol was introduced. In the USA, a fall in petrol lead of 55 per cent was accompanied by a fall in blood level of 30 per cent (in children 40 per cent). The following table gives a few representative trend of blood lead levels:

	1967	1981
Japan	21.0 microgrammes/ 100 ml	6.0 microgrammes/100 ml
Israel	15.0 ,,	8.2 ,,
USA (Baltimore City)	18.0 ,,	7.5 ,,
Yugoslavia	15 0 ,,	9.2 ,,

Whatever alternative explanations are offered to account for these changes, they appear somewhat strained when set against the more obvious conclusion that petrol is the main source of lead in human beings.

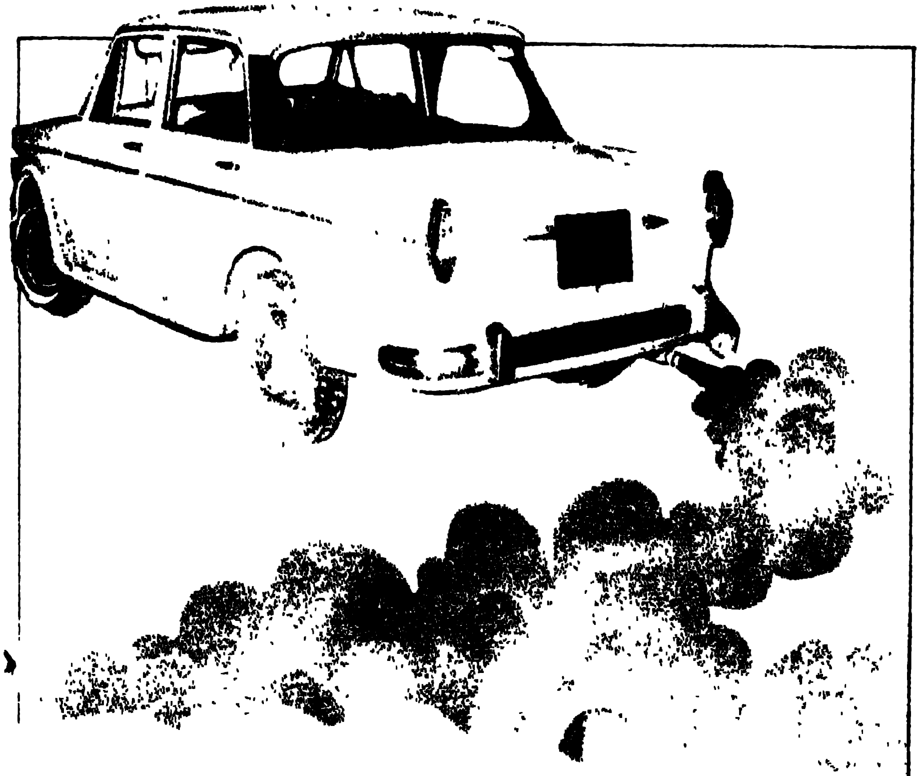
Lead is potentially toxic. It can affect brain function, the nervous system and the kidneys. In the early stages, lead poisoning causes several non-specific symptoms—irritability, headache, loss of appetite, tiredness, etc. If unchecked, it can lead to loss of muscle power, colic, psychological disturbances, permanent impairment of the central nervous systems and disease of the kidney Children up to 5 years are particularly vulnerable because of their developmental state Laboratory data have shown that mental development in children can be affected even at low lead concentrations

The problem is, there is really no evidence for a threshold at which lead begins to have toxic effects, though, for practical purposes, some standards have been set—15 to 20 microgrammes per 100 ml of blood by the US National Science Academy and 30 microgrammes per 100 ml of blood by the European Economic Community as tolerable levels of lead in blood. However, toxic effects are now being found at much lower levels, and the most recent evidence by Dr. Needleman of the USA suggests that they may be close to or perhaps even below the current background levels. Until low-level lead toxicity, incorporating 'unpolluted' control group, can be studied, the recommendation of a committee of the US National Academy of Science that a serious effort should be made to reduce the base line level (15 to 20 microgrammes per 100 ml of blood) of exposure to lead for the general population should be carefully considered in every industrialised country.

To understand the magnitude of the problem, a study of atmospheric lead pollution was undertaken in Bombay sometime ago. The study covered sources of lead in the atmosphere, levels of lead in different zones and in surface soil, lead intake from air, water, food and cigarette smoke and the concentration of lead in blood and teeth in the Bombay population. Most of the sites studied showed a significant correlation between airborne lead and vehicular traffic, suggesting that automobile exhaust emission is the main source of airborne lead in Bombay.

Atmospheric lead concentrations were high (500-590 nanogrammes per cubic metre) at Fort, Phule Market and King's Circle where the traffic density is high; lower (320-385 nanogrammes) at Worli, Byculla and Parel which are industrial-cum-residential areas and the lowest (82-85 nanogrammes) at Trombay and Deonar which are suburban areas with low traffic. Compared

The use of higher octane petrol from last September will increase atmospheric lead and, consequently, raise blood lead levels in the urban population; nearly half the Bombay population, for instance, will exceed the tolerable blood lead level by the end of the decade



to these, Matheran, a hill station 50 km east of Bombay where no motor vehicles are allowed inside the town, had only a concentration of 16 nanogrammes per cubic metre. Most of the lead particles are produced during daytime when the traffic density of petrol-driven vehicles is high.

The lead particles were found to be distributed in two size groups—one in the size range of 0.43-0.65 micrometres and another in the range 3.3-4.7 micrometres in diameter; at Matheran, there was only one size group—0.43 to 0.65 microgramme. Apparently, burning of leaded petrol is a possible source of the smaller particles, and deposits of exhaust material and resuspension of lead dust settled on the street are the likely sources of the larger particles.

To know this size distribution is important. For, on this depends how much of the lead particles one inhales reaches the lungs. Normally, the larger particles (larger than 5 micrometres in diameter) are trapped in the nosopharyngeal region while the smaller particles penetrate deep into the lungs and hence can enter the blood stream. About 70 per cent of the lead particles observed in the Bombay study was in the smaller, respirable size. The smaller particles also remain in the air for long and may be carried far away while the larger particles settle and get deposited near the source of emission—on streets and land nearby. Leafy portion of vegetables close to highways may, therefore, have a higher lead concentration, half of which could, of course, be removed by washing

Indeed lead concentrations in surface soil in Bombay have been increas-

Lead in petrol vs lead in blood

A RECENT United Nations Environment Programme (UNEP) survey on blood lead reveals some interesting data on blood lead levels and exposure to lead from petrol. Mexico, for instance, has the highest concentration of lead in petrol (0.9 g per litre) among the countries surveyed; Mexico City has also an extremely heavy automobile traffic. The City residents have higher blood lead levels (22.5 microgrammes per 100 ml of blood) than many other cities. The population groups studied in Beijing and Tokyo showed lower blood lead levels. Tokyo, like Mexico City, is a large city with heavy traffic but almost all petrol used is unleaded. Beijing has a low automobile traffic and, besides, about 75 per cent of the petrol used is unleaded. The other countries studied have intermediate concentrations of lead in petrol and also intermediate blood lead levels (UNEP, 1981 survey), as shown in the table.

Country	Blood lead concentration (median value)	Lead content g/litre
Belgium (Brussels)	15.0 (microgrammes per 100 ml)	0.84 0.45 (since 1.1.76)
China (Beijing)	6.4	75% unleaded petrol
India		
Ahmedabad	13.8	0.57 (1.10.72)
Bangalore	17.9	0.64 (1.10.83)
Calcutta	10.7	
Israel (Jerusalem)	8.2	
Japan *(Tokyo)	6.0	Lead-free
Mexico (Mexico city)	22.5	0.9
Peru (Lima)	9.6	–
Sweden (Stockholm)	7.2	–

Another study in the US in 1980 showed that traffic policemen and automobile tunnel employees in Cincinnati, Los Angeles and Boston had a much higher exposure to atmospheric lead and, consequently, higher blood lead levels. For instance, while urban US citizens in general had an average exposure of 1 microgramme per cubic metre and a mean blood level of 21 microgrammes per 100 ml, policemen and automobile tunnel employees mentioned above had an exposure of 3.8 to 6.3 microgrammes and a blood lead level of 30 to 31 microgrammes per 100 ml.

R.N.K.

ing. Soil samples collected from the Aarey area in 1960 and 1976 showed that the lead concentration had increased from 13.6 microgrammes to 41 microgrammes per gramme of soil over these years—an annual average increase of 1.3 microgramme per gramme of soil. Figure 2 shows the estimation of the increasing trend of lead in surface soil in Bombay along with the number of vehicles and petrol consumption. It may, therefore, be interesting to study if school playgrounds near major roads with heavy vehicular traffic have higher concentrations of lead. For, school children who dirty their hands with the soil while playing may then be ingesting more lead because of their careless habits.

Considering also the lead intake from food, water, air and cigarette smoke (see Table 2), an average person in Bombay absorbs a total of 29.5 to 47.5 microgrammes of lead a day; a non-smoker living in downtown Bombay absorbs about 33 microgrammes of lead per day, about 75 per cent of that coming from food, 15 per cent from air and 10 per cent from water.

But what is important is the amount of lead that gets into the blood. To assess this, blood samples from individuals who had no known industrial exposure to lead were analysed (using a very sensitive technique—differential pulse anodic stripping voltammetry). The blood lead levels in Bombay residents varied from 9.6 to 37.3 microgrammes per 100 ml of blood, with an average value of 17.7 microgrammes per 100 ml; men had a higher average (18.4 microgrammes) than women (16.9 microgrammes). Compare this with the average blood lead of 12.1 microgrammes per 100 ml for a small group of Pune residents, and a still lower value of 9.4 microgrammes for children in a 'clean area' in Bombay—Anushakti Nagar in Deonar with negligible traffic. Compare these also with average blood lead concentration of only 5 microgrammes per 100 ml in children from an unpolluted area in Papua, New Guinea, and 3 microgrammes for a Nepalese population from the

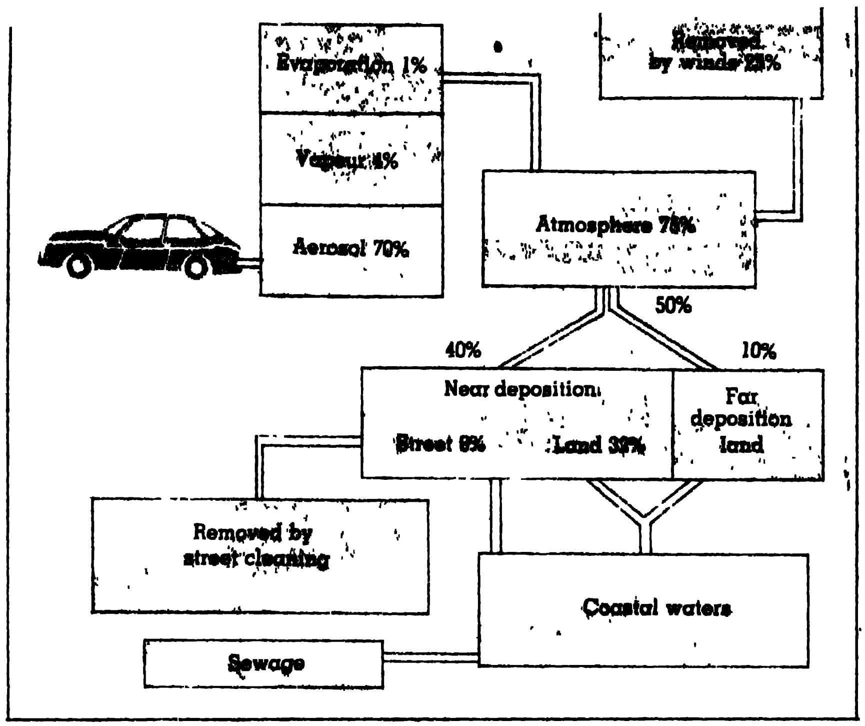


Fig. 1 Dispersion and distribution of lead from automobile exhaust in Bombay

Table 1. Airborne concentrations of lead in different zones of Greater Bombay during 1979-80

Location	Lead in nanogrammes per cu metre
Deonar	82
Trombay	85
King's Circle	520
Parel	337
Byculla	384
Worli	326
Phule Market	591
Fort	550
Matheran	16

Himalayan foothills. These concentrations of 3 to 5 microgrammes have, therefore, to be considered as 'base lines'.

While the blood lead level reflects the exposure to lead over the preceding few weeks or months, it doesn't indicate if a person had been exposed to lead more intensely in the past; a more meaningful index in such cases would be the lead content in tissue such as teeth, where it accumulates over long periods. The teeth lead content in the Bombay adult residents studied ranged from 4.3 to 82.5 microgrammes per gramme of tooth, with an average value of 15.5 microgrammes. In children, in the age group 7-12 years, the teeth lead content measured an average of 5.2 microgrammes per gramme of tooth

In the USA, during a nationwide survey for childhood lead poisoning, Dr. Needleman and his coworkers used dentine lead content as a marker of previous exposure to lead and they found that children with high dentine lead performed significantly lower on IQ tests than those with a low teeth lead content.

Towards low-lead petrol

Because automobile sources contribute over 90 per cent of the lead in the urban atmosphere, most regulations for reducing the atmospheric lead levels are directed at the automobile tail pipes—installation of pollution control devices in old cars, design of new cars that burn lead-free (or low leaded) fuel, etc. Though several devices have been developed to trap particulate matter from exhaust gases in old cars, they have not been popular for various reasons. The thrust has, therefore, been towards reducing the use of low-lead or lead-free petrol.

The constant efforts by engine designers to have more powerful and efficient petrol engines have lead to the increase of the compression ratio from 4:1 in the 1920's to as high as 11:1 in modern engines. Earlier engines had low compression ratios mainly because of the low octane numbers of the petrol that was available those days. The development of new refining techniques and more significantly the discovery of lead antiknocks for economically

Laboratory data show that mental development in children can be affected even at low lead concentrations

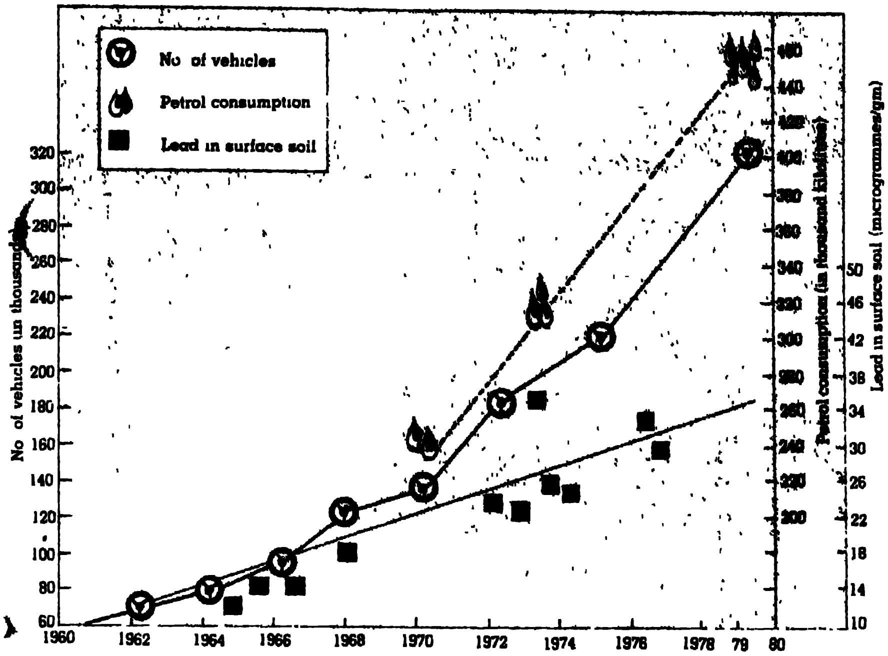


Fig. 2 Increasing trends of petrol consumption, number of vehicles and soil lead concentrations in Bombay

Table 2. Average daily uptake of lead

Substance	Average daily intake	Daily lead intake microgra-mmes/day	Fraction absorbed %	Daily lead uptake microgra-mmes	Normal range microgra-mmes
Food	—	245	8-10	24	20-30
Water	3.5 litres	42	8-10	4	3-5
City air	15-20 cu m	10	50	5	3-6
Suburban air	15-20 cu m	2	50	1	0.5-1.5
Cigarette smoke	10	8	50	4	3-5

increasing the octane number of motor spirits have been mainly responsible for this progress. The modern well-balanced gasolines of high octane numbers are produced by a judicious choice of refining techniques and the addition of small quantities of lead antiknocks. It is possible to produce totally lead-free petrol of the required octane number by the addition of aromatic or olefinic fractions but the cost of such fuel will be higher.

In India, much of the petrol sold till last year had the octane number (RON) 83, though a small quantity of 93 RON petrol was available in some big cities to cater to the imported high compression ratio cars. While public concern about air pollution caused by automobile vehicles is being increasingly expressed in our country, not much work has so far been done to establish the actual magnitude of the problem and the degree of control that is required at least with regard to lead antiknocks. This problem has become more sensitive since September 1983 when the octane number was boosted from 83 to 87 (the lead level in petrol will go up from 0.54 g/litre to 0.62 g/litre).

Indian cars are powered by low compression ratio engines resulting in poor fuel economy. It has been shown that 83 RON petrol gives knock-free operation to only about 40 per cent of Indian cars. If the octane number is raised to 87, and the compression ratio of Indian cars is raised by one unit, the fuel economy of cars is estimated to improve by about 7 per cent. However, the atmospheric lead level is likely to go up by about 12 per cent, increasing blood lead levels of the Bombay population by 8 to 10 per cent within a short time. The future levels could be estimated with the help of a mathematical model which relates the total lead exposure and blood lead levels in the adult population.

During 1960-70 the number of autovehicles in Greater Bombay increased by 60 per cent and during 1970-80 by 100 per cent. If one assumes the same rate of increase to continue, there will be 4.5 lakh cars in Greater Bombay at the end of this decade, consuming about 750,000 kilo litres of petrol. Thus, in 1990, automobile exhausts would release 450-500 tonnes (for 87 RON) into the atmosphere compared to 250 tonnes in 1979-80. The average atmospheric lead concentrations at Fort, Phule Market and King's Circle areas would be in the range of 1.2—1.5 microgrammes per cubic metre, and a higher fraction of this will be in the smaller respirable size. This will certainly affect the blood lead content. This would call for continuous monitoring of the blood lead in Bombay residents by health authorities, particularly in children. It would help to use exhaust traps and also grow trees to trap the lead particles in vehicular traffic zones and near schools.

Dr Khandekar is with the Air Monitoring Section of the Bhabha Atomic Research Centre, Bombay. He obtained his PhD from Bombay University in 1981 for his study of atmospheric lead pollution in Bombay. His main interests are the development and use of trace element analysis techniques in environmental studies

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AMAZING NUMERIC KEYBOARD

ALMOST all the numeric keyboards are arranged in the format shown in Fig 1 Discarding zero, this formation exhibits interesting patterns when added vertically, horizontally and diagonally in rows and columns in single or grouped together. In order to identify rows and columns in their appropriate directions, each one is assigned with an identification letter. Rows from left to right are identified as a, b and c, and rows from right to left are **a**, **b** and **c**. Similarly columns from bottom to top are labelled **x**, **y** and **z** and top to bottom are x, y and z. Examples of row/column identification:-

a=123; **a**=321   x=741; **x**=147
b=456, **b**=654   y=852, **y**=258
c=789, **c**=987   z=963; **z**=369
ab=123456; **cb**=789654
xy=741258, **yz**=258369

and so on

1) Taking rows and columns in single,
1. a+c=b+b (123+789=456+456=912)
2. x+z=y+y (741 + 963 = 852 + 852 = 1704)
3. **a**+**c**=**b**+**b** (321+987=654+654=1308)
4. **x**+**z**=**y**+**y** (147+369=258+258=516)
5. (a+c)+(**a**+**c**)=(x+z)+(**x**+**z**)
=2(b+**b**)
=2(y+**y**)
=2220
6. b+**b**=y+**y** (456 + 654) = (852 + 258) = 1110

2) Taking rows in group of two,
1. ab+cb=ba+bc (123456 + 789456 = 456123 + 456789)
2. **ab**+**cb**=**ba**+**bc** (321654 + 987654 = 654321 + 654987)
3. xy+zy=yx+yz (741852 + 963852 = 852741 + 852963)
4. **xy**+**zy**=**yx**+**yz** (147258+369258=258147+258369)
Combining the above four results we get,
5. (ab+cb)+(**ab**+**cb**)=(ba+bc)+(**ba**+**bc**)
=(xy+zy)+(**xy**+**zy**)
=(yx+yz)+(**yx**+**yz**)
=2222220

3) Again taking rows and columns in group of two,
1. **ab**+**cb**=**ba**+**bc**   2. ab+cb=ba+bc
3. **xy**+**zy**=**yx**+ **yz**   4. xy+**zy**=yx+yz
Combining the above four results we get,
5. (**ab** + **cb**) + (**ab** + **cb**) = (**ba** + **bc**) + (**ba** + **bc**)
=(**xy**+**zy**)+(**xy**+**zy**)
=(**yx**+**yz**)+(**yx**+**yz**)
=2222220

Results of 2 5 and 3.5 are identical.

4) Rotating the columns by one position to form a new arrangement as shown in Fig. 2, and re-labelling columns and rows as indicated, we can develop identical results.
1. ab + cb = ba + bc (312645 + 978645 = 645312 + 645978)
2. **ab** + **cb** = **bc** + **ba** (213546 + 879546 = 546879 + 546213)
3. **ab** + **cb** = **ba** + **bc** (312546 + 978546 = 645213 + 645879)
4. **ab** + **cb** = **ba** + **bc** (213645 + 879645 = 546312 + 546978)
Combining the above four results we get,
5. (ab+cb)+(**ab**+**cb**)=(ba+bc)+(**bc**+**ba**)
=(**ab**+**cb**)+(**ab**)+**cb**)
=(**ba**+**bc**)+(**ba**+**bc**)
=2384382

Now consider columns,
(xy+zy)−(yx+yz)=(**xy**+**zy**) −(**yx**+**yz**)
= (**xy**+**zy**)−(yx+**yz**)
= (**xy**+**zy**)−(yx+yz)
= 332667

5) Rotate again the columns by one more position and re-label rows and columns as indicated in Fig. 3.
1. ab+cb=ba+bc   2 **ab**+**cb**=**ba**+**bc**
3. **ab**+**cb**=**ba**+**bc**   4. ab+cb=ba+ **bc**
Combining the four results,
5. (ab+bc)+(**ab**+**cb**)=(ba+bc)+(**ba**+**bc**)
=(**ab**+cb)+(ab +**cb**)
=(**ba**+**bc**)+(**ba**+**bc**)
=2060058

Obtaining similar results from column additions,
(yx+yz)−(xy+zy)=(**yx**+**yz**)−(**xy**+ **zy**)
=(**yx**+yz)−(xy+zy)
=(**yx**+yz)−(xy+**zy**)
=332667

6) Rotate the rows by one position from the original format and label columns and rows as indicated in Fig 4
Performing column additions,
1. xy+zy=yx+yz   2 **xy**+**zy**=**yx**+**yz**
3. **xy**+**zy**=yx+**yz**   4 xy+zv=yx+yz
Combining the above.
5. (xy+zy)+(**xy**+**zy**)=(yx+yz)+(**yx**+**yz**)
=(**xy**+zy)+(xy+zv)
=(**yx**+yz)+(yx+yz)
=1735734

Obtaining similar results from row additions,
(ba+bc)−(ab+cb)=(**bc**+**ba**)−(**ab**+**cb**)
=(**bc**+**ba**)−(**ab**+**cb**)

Fig.1

	x	y	z	
c	7	8	9	c
b	4	5	6	b
a	1	2	3	a
	x	y	z	

Fig.2

	x	y	z	
c	9	7	8	c
b	6	4	5	b
a	3	1	2	a
	x	y	z	

Fig.3

	x	y	z	
c	8	9	7	c
b	5	6	4	b
a	2	3	1	a
	x	y	z	

Fig.4

	x	y	z	
c	1	2	3	c
b	7	8	9	b
a	4	5	6	a
	x	y	z	

Fig.5

	x	y	z	
c	4	5	6	c
b	1	2	3	b
a	7	8	9	a
	x	y	z	

Fig.6

	x	y	z	
c	3	1	2	c
b	9	7	8	b
a	6	4	5	a
	x	y	z	

Fig. 1 General arrangement of keyboard. Fig.2 and 3 first and second column rotation. Fig.4 and 5 first and second row rotation. Fig.6 and 7 first and second row and column rotation respectively

Fig.7

	x	y	z	
c	5	6	4	c
b	2	3	1	b
a	8	9	7	a
	x	y	z	

8(a)

	x	y		
b	4	5		b
a	1	2		a
	x	y		

8(b)

		y	z	
b		5	6	b
a		2	3	a
		y	z	

8(c)

	x	y		
c	7	8		c
b	4	5		b
	x	y		

8(d)

		y	z	
c		8	9	c
b		5	6	b
		y	z	

Fig.8 Formation of 2×2 matrix

FORGOTTEN MAN OF SCIENCE

Professor Keru Lakshuman Chhatre

THE western India of 1818. The Marathas had fallen to British forces led by Mount Stuart Elphinstone. The natives on the whole welcomed the Company's rule, because they were weary of a decayed and disintegrated social life.

The most notable change that took place with the new rule was in the field of education. When Macaulay's Minute on education was made public in 1835 it was clear that western education, if imported, would strike roots in India. The new educational policy led to the introduction of English language and development of science and technology. A spirit of enquiry and learning was revived.

It is against this background that one has to view the life and work of Professor Keru Lakshuman Chhatre, one of the outstanding men of science in his day. Nineteenth March, 1984, marks the centenary of the passing away of this extraordinary astronomer and mathematician.

Born in a poor family, at Walkeshwar, in 1824, the son of a *bhikshu*, Professor Chhatre inherited no fortunes. His life was a story of grit and courage, who preserved a child's curiosity to the very end. It was this compulsive urge to know the 'why' and 'how' of things that made him stand head and shoulders above his contemporaries.

In Professor Chhatre we had the rare combination of intellect and imagination. All his life he was attracted to the profound secrets of science. Though he retired as a Professor of Mathematics from Deccan college in Pune in 1879, he remained a student of science throughout his life.

Professor Chhatre absorbed the best of both worlds, training a naturally contemplative mind in the scientific methods of the West. Along with his endowments, he had the capacity for hard work which fetched him the post of an assistant at Bombay Observatory in 1840. He soon became an authority on the theoretical and practical aspects of astronomy.

In 1851 he joined the Poona College, precursor of Deccan College, as an Assistant Professor. For two years he worked as a Principal in an English school at Ahmednagar. After a short stint at Poona Training College as superintendent, and at Elphinstone as Professor of Mathematics, he began his long association with Deccan College. He was the acting principal of the college from 1875 to 1876. On his retirement as Professor of Mathematics the Government at the time accorded him a pension of Rs 5,000 per year, a rare honour in those days. He was also presented with a silver medal and the title of Rao Bahadur in recognition of his achievements.

His contributions to science include his efforts to solve the difficulties involved in the inequalities of the moon's motion. Like Laplace and Jeans, he too had his own theory with regard to the origin of the Earth which he illustrated with diagrams.

Professor Chhatre took keen interest in the theory of hyper space, a domain almost exclusively frequented by scientific fiction writers. He was also the first Indian astronomer to relate the appearance of sun-spots and years of scarcity and famine. 'He will be known to the future generations in the Deccan as the Aryabhatta of modern time" said the *Times of India* (20 March, 1884) paying tributes to this great man. He was aptly called so for his capacity to inter-relate and organise different aspects of knowledge.

Professor Chhatre has written three books in Marathi *Grahasadhananchi Koshtake'* (1860), *'Tithichintamani'*, and *'Panchanga Sadhana Koshtake'* (1861). He has been instrumental in reforming the Hindu calendar. He has translated English mathematical works into Marathi and written text books on Physics and mathematics. He suggested graded teaching of mathematics and wrote his books "for anyone interested in learning". He was one of the earliest persons to develop Marathi scientific terminology. Simplicity, lucidity and clarity differentiated his books from others.

The Times of India
Reference Service

−(bc+ba) (ab+cb)
−998001

7) Rotate again through one more row and re label as shown in Fig 5. Performing column additions

1 xy+zy vy+vz   2 xy+zy vx+yz
3 xy+zy=vx+vz   4 xy+zv−vy+yz

Combining the four results

5 (xy+zy)+(xy+zy) −(yx+yz)+(vx+yz)
−(xy+zy)+(xy+zy)
(vx+yz)+(yx+yz)
−708706

Obtaining similar results from row additions

(ab+cb) − (ba+bc)=(cb+ab)−(bc+ba)
=(cb+ab)−(bc+ba)
−(cb+ab)−(bc+ba)
=998001

8) Rotate rows and columns through one position from the original format and re label as shown in Fig 6 and in Fig 7.

Performing additions and subtractions is carried out as in previous cases result of rows 998001 result of columns 552667

9) 2 2 Matrix formation

Four in number 2 2 matrix formations can be developed from the original format of keyboard this is shown in Fig 8 to d

1 Considering Fig 8 (a) and (b)
(yx+yz) (xy+zy) (2541 2563 1452 + 3652)

2 Considering (a) and (c)
(ab+cb)−(ba+bc)(4521 + 4587 = 1254 + 7854)

3 Considering (c) and (d)
(xy+zy) − (yz+yx) (7458+9658 = 8596+8547)

4 Considering (b) and (d)
(ab+cb) (bc+ba) (3256+9856 6523+6589)

5 Combining the above derived results
(yx+yz)+(xy+zy) (xy+zy)+(yz+yx)
(ab+cb)+(ab+cb)
(ba+bc)+(bc+ba)
22 20

Computing diagonally each matrix in a repeating pattern

i) (5986+5124) (5226+5781)
ii) (1524+9586) (3526+7584)

Exploring these interesting patterns and their results is worth an effort. Results of matrix formation after row and column shifts are left to readers.

George Varkey

Lieutenant Commander George Varkey is in the Indian Navy since 1971. He has been awarded by National Research Development Corporation for Meritorious Invention in August 1982.

"The Salamander is the mythical beast of the Greeks... the creature that defies death and decay," Anil said to Medha. He was trembling with excitement...

SQUABBLES among Surgeons", screamed the headline. The news spread like wild fire. Never before had a junior been promoted over the head of his senior in the Department of Surgery at one of Bombay's well-known hospitals—where promotions, so far, had been strictly on the basis of seniority.

The newspapers lost no opportunity to highlight the "supersession". And column after column was devoted to the controversy. Some praised the prodigy, Dr. Anil Vishwas. Some welcomed his elevation as a progressive decision. For in our country too many old people occupy too many positions for too long. What are the talented juniors to do? Wait in the queue till the elders either retire or die? Dr. Vishwas was regarded as a medical wizard of India. He had a string of degrees after his name. But his rival Dr. Bhujbal, too, had those degrees. In fact, not so long ago, Bhujbal had taught Vishwas. But the pro-Vishwas elements countered that in almost all professions, particularly in medicine, degrees had a very limited value. They seldom described real talent. But it was to his credit that at the age of 36, Dr. Vishwas was appointed as the Personal Surgeon to the President of India. It was an unprecedented honour. Also, the first-ever lung transplant operation had been performed under his guidance. It was done in New York simply because the sophisticated equipment necessary for the operation wasn't available in India. An article praising that epic operation had described Dr Vishwas as "the surgeon who amputates the hands of Yama".

But the "Boy Wonder" had his detractors. They characterised his promotion as improper and contemptible. They had no comments on Vishwas's abilities, which they grudgingly acknowledged. But they pointed out that Dr. Bhujbal was no less qualified. Being senior in age—Bhujbal was 52—his experience should have been considered for the post. After all, experience was a vital factor in medicine. Moreover, they pointed out, it would have been befitting that Bhujbal be promoted towards the end of an illustrious career. For he had barely six years before he retired. The post would then have surely gone to Dr. Vishwas. And as far as the well-publicised lung transplant operation went, the pro-Bhujbal newspapers pointed out that it could well have been done by Bhujbal himself, (but for the unfortunate bereavement in his family which prevented him from going). They also pointed out that the original article describing the method, which fetched the US invitation, had been published in the Indian Medical Journal under the joint names of Bhujbal and Vishwas.

Outwardly the two protagonists gave no indication of their feelings. Even Medha, Vishwas's wife and herself a practising physician, was also unable to fathom her husband's mind. Whenever she broached the topic of promotion he would side track the issue. Invariably he would laugh saying, "Medha, as far as I can see, you are the better surgeon... better than both of us..."

And Medha was puzzled.

"...You have performed an absolutely bloodless surgery. You have created a place for yourself in my heart—without opening it! It's a real miracle!"

She would smile and look fondly at her husband. When her eyes sparkled, it was difficult to say whether they reflected pride or a sense of fulfilment at her husband's gallant tribute or wonder at his skilful parrying.

The controversy gradually subsided. The newspapers took some other contentious bones to chew. But an uneasy silence prevailed in the Department of Surgery at the hospital.

And then that terrible accident took place. Dr Vishwas's survival was really quite miraculous.

He had been walking along a footpath in the congested area of Girgaum and suddenly a portion of the balcony collapsed directly over him. He fell unconscious. As bad luck would have it, a large chunk of R.C.C. which was precariously hanging, fell on his outstretched right hand, crushing those shapely, sensitive fingers completely!

Dr. Vishwas was rushed to the Hospital. Medha and Dr. Bhujbal were called in. The injuries on his head were deep but not serious. Fortunately there was no damage to the brain. Only suturing was needed.

But his hand was a tragic mess: The concrete block which had fallen on Dr. Vishwas's hand was full of rusty iron skewers. And the fingers were pulped under the enormous impact. Anil had lost a lot of blood. And there was every possibility of gangrene creeping in.

There was only one remedy: Amputation.

The situation was so grave that it brooked no further delay. Dr. Bhujbal explained all the possible complications of the case to Medha. After all, Mrs. Vishwas too, was a physician. She fought back her tears as she signed the form permitting surgery.

And that afternoon, Dr. Anil Vishwas, M.S., F.R.C.S., Padma Bhushan, lost four fingers of his right hand...

When Dr. Vishwas came to his own the next day, Dr. Bhujbal was near his bed. He explained the whole situation to him. Medha who held her husband's left hand, winced in pain as he clenched it involuntarily.

"I am so sorry Dr. Vishwas, but I am sure, even without the fingers you can still give us your valuable advice," Dr. Bhujbal was saying. Dr. Vishwas was gazing at the ceiling. His face was completely emotionless. His eyes were blank. How much of what Dr Bhujbal was saying came out of sincere grief and how much out of sadistic pleasure? he wondered.

After the accident, although the management of the Hospital retained Dr. Vishwas as the Head of the Department of Surgery, he resigned on his own. "You can't teach swimming by standing on the banks of a river. A surgeon who cannot operate has no right to teach", he wrote in his letter of resignation.

Naturally, his resignation attracted wide publicity in the newspapers. They spared no words in praising his sincerity. But that was the last thing written about Dr. Vishwas. He went out of limelight and was soon totally for-

The Salamander Factor

Laxman Londhe

ILLUSTRATION BY FRANCIS D SA

gotten.

Thus began the lon[illegible] anonymity in the life of Dr. Anil Vishwas: No challenges. No [illegible] The flow of money reduced [illegible] Medha Vishwas had to bear the [illegible] of keeping the home fires burning [illegible] her income through the general [illegible] tice was at best adequate.

She used to attend her dispensary twice a day. And she [illegible] busy. Since Dr. Vishwas had [illegible] do except brood over the [illegible] increasingly moody [illegible] became morose, silent [illegible] times for days he would not [illegible] word.

Once in desperation he said to his wife: "I'm sure Dr. Bhujbal amputated my fingers on purpose. He was jealous of me. He took advantage of my unconscious state."

Although she felt sorry, Medha was also angry. She was a doctor in her own right and had given the permission for the operation. In her case, permitting an operation on a relative who is unconscious was no mere routine. Anil's suggestion therefore amounted to an insinuation against her.

"Please don't say that. Think logically. You think I'd permit the operation if it was not to save you? You feel I, too, was jealous of you?" she pleaded.

Dr. Vishwas kept staring at her silently.

As the days went by, it was becoming difficult to take care of Anil. Medha's dispensary left her little time. She came home in the afternoons for a quick lunch and was greeted by her glum-faced husband. She expected him to join her. But at times, he'd finish before her. And on the day he had not had his lunch, he'd decline to come to the dining table. He would mumble: "Have your lunch in time. Every one who's busy must eat well, must eat in time. Not a lazy waster like me. I do no work, lunch is a luxury for me! Should I eat every day?" he would ask sarcastically.

Medha tolerated him somehow. In the meanwhile Dr. Vishwas had taken to reading. Earlier he'd read nothing [illegible] reading [illegible] she ret[illegible] unhappy [illegible]

Medha [illegible] she did not know [illegible]

After [illegible] her work [illegible] stopped her. [illegible] Tukaram and [illegible]

"No Medha, [illegible] watched death [illegible] defeat! I'll show [illegible] gers aren't [illegible] rebirth. And [illegible] great... probably [illegible] to sing about [illegible] before, but it must [illegible] must!"

He looked radiant, almost euphoric. Medha felt even more [illegible] Had he finally become unhinged? [illegible] Medha returned from the dispensary in the evening next day, she found the house locked. A small note was tucked in the bolt: "I am in the Hospital Library. [illegible] have kept the keys with our neighbour. [illegible] loves, Anil."

The Librarian was surprised to see Dr. Vishwas. He had never visited the Library. As the Head of the Department, he would always send a peon for the books he required. The Librarian was seeing him for the first time. "... No need to be surprised. I am not the Head of the Department any more, you know... now just an ordinary student," Dr. Vishwas remarked.

[illegible] morning [illegible] would [illegible] Medha to go to the dispensary [illegible] breakfast on the table and [illegible] when she returned in the evening, [illegible] Vishwas would be out.

They met each other one Sunday at [illegible] "Medha, three months from [illegible] you will have to close your [illegible] practice," Dr. Vishwas said. He appeared buoyant, bubbling with good humour.

Medha felt relieved [illegible] seen her husband [illegible] few months. But [illegible] could not [illegible] exuberance. [illegible] practice wo[illegible] than half of the[illegible] any [illegible] Why? [illegible] special?" [illegible] special. [illegible] I am still [illegible] within three [illegible] I shall have to start [illegible] my experiments—the experiments which will revolutionise medicine. [illegible] give me a new life but [illegible] epoch-making. And I [illegible] need you then, as my assistant, as my co-worker. Don't you worry over trifles like your general practice."

"O.K., but let me know what the matter is."

"I'm going to defeat Dr. Bhujbal. I'm going to resume my own practice as a surgeon."

"Without the fingers on your right hand!"

"... who said so? Of course *with* the fingers on my right hand!"

Medha could not suppress her laughter. She said, "I've heard of donations of cornea, blood and even kidneys. But fingers? And even if you find such a donor, how do you propose to stick them on your hand? Are you going to try fevicol?"

"Please, Medha don't [illegible] serious" said Dr. Vish[illegible]

"But the human bo[illegible] make its c[illegible] O.K. Ev[illegible] at. Even[illegible] ked at. [illegible] I have co[illegible] and I'll make history [illegible] believe, but would y[illegible] Vishwas started narr[illegible] ... said:

"The human body [illegible] numerable cells but [illegible] single cell—the cell [illegible] union of an ovum [illegible] cell [illegible] chromosomes from the [illegible] contain the complete [illegible] complete chain [illegible] future development of [illegible] who has to grow from [illegible] process of cell division [illegible] geometric proportion. [illegible] of cells increases [illegible] takes place. Each new cell [illegible] to perform a specific [illegible] body of the [illegible] cell is directed and ordered to take [illegible] a particular function and be a part of a specific organ. A cell is ordered to be a part of the skin, another is told to be a part of the eye and so on. Who instructs these cells? Who is the great conductor of the cellular symphony? Scientists have identified the [illegible] and named him too. He is known as platelet-derived growth factor (PDGF). PDGF is [illegible] to the [illegible] small group of genes. [illegible] ly produced by specialised cells (platelets) in the blood and it stimulates growth in certain specific tissues. It sends a signal to the newly produced cell. How is this signal, this order, this information passed on? By means of an electrical impulse. Correct. Are you following me? [illegible] know this... [illegible] group of cells [illegible] the individual [illegible] received. The foetus [illegible] The shapeless lump sorts [illegible] a superb shape...

"All this sounds like metaphysics or [illegible] [illegible] his wife intent[illegible] laugh. I am not talking nonsense. Other scientists support my view. Dr. Robert Baker of Veterans Administration Hospital, Syracuse,

[illegible] these questions [illegible] months. And I think [illegible] the answer. I now believe [illegible] regain this marvellous [illegible] regeneration."

[illegible] interest was caught. [illegible] amazement at [illegible] hand as he waved it [illegible] her.

[illegible] phenomenon involves two stages," Anil continued. "Let us see what happens to the blood cells at the place of the injury. In human beings PDGF does not become active on injury. In fact, it gets destroyed. The [illegible] secondary job of [illegible] at the injury. The [illegible] to keep PDGF active [illegible] only we can do that. [illegible] more than [illegible]

[illegible] York was the pioneer. He has [illegible] ded this theory way back in [illegible] Dr. Andrew Besset of Columbia [illegible] erian Medical Centre and his [illegible] ates have made experiments in [illegible] direction. They have so far been [illegible] ssful in rejoining bones.

"But I am going a lot further. I'll have to do just two things. I'll have to [illegible] the cells in my amputated hands [illegible] care to see that PDGF does not [illegible] destroyed in the process. I have discovered a virus which will do the [illegible]. Immediately after the injury we will have to inject that virus at the place of the injury. We then need a very minute electrical impulse. This will activate the PDGF. The cells will then continue to take birth and also continue to take over the specific [illegible] of becoming my fingers [illegible]

"I am impatient [illegible] experiment on [illegible] didn't want my [illegible] resurrect my [illegible] beloved fingers [illegible] meant, he [illegible] death and found the [illegible] exhilarating. I am going to experience resurrection and I am sure the experience would be nothing less than ecstatic—and you are going to be a participant in this great experiment in human history."

Two years later Dr. Anil Vishwas met Dr. Bhujbal in his consulting rooms at Opera House.

"Hello! Sir," said he, extending his right hand.

Dr. Bhujbal stared at the hand in surprise. He could not believe his eyes. The hand was complete! Down to the smallest half moon on the healthy pink fingernails! Stroking him on his back, Dr. Vishwas continued, "Dr. Bhujbal, you seem to be upset. But you won't lose your post of the Head of Department of Surgery. You need have no cause of concern on that count. And if you wish to know more about my regrown fingers, you had better read the forthcoming issue of the Journal of Indian Medicine. Come let us shake our hands..." Once again Dr. Vishwas extended his hand.

Laxman Londhe is a prolific sci-fi writer.

The adventures of the first infrared astronomical satellite (IRAS) which is providing breathtaking views of the universe never seen before... dust clouds, brand new comets and asteroids, ringed stars and baby suns tucked away in dark, unexpected quarters of the galaxy

IRAS IN WONDERLAND

Vithal C. Nadkarni

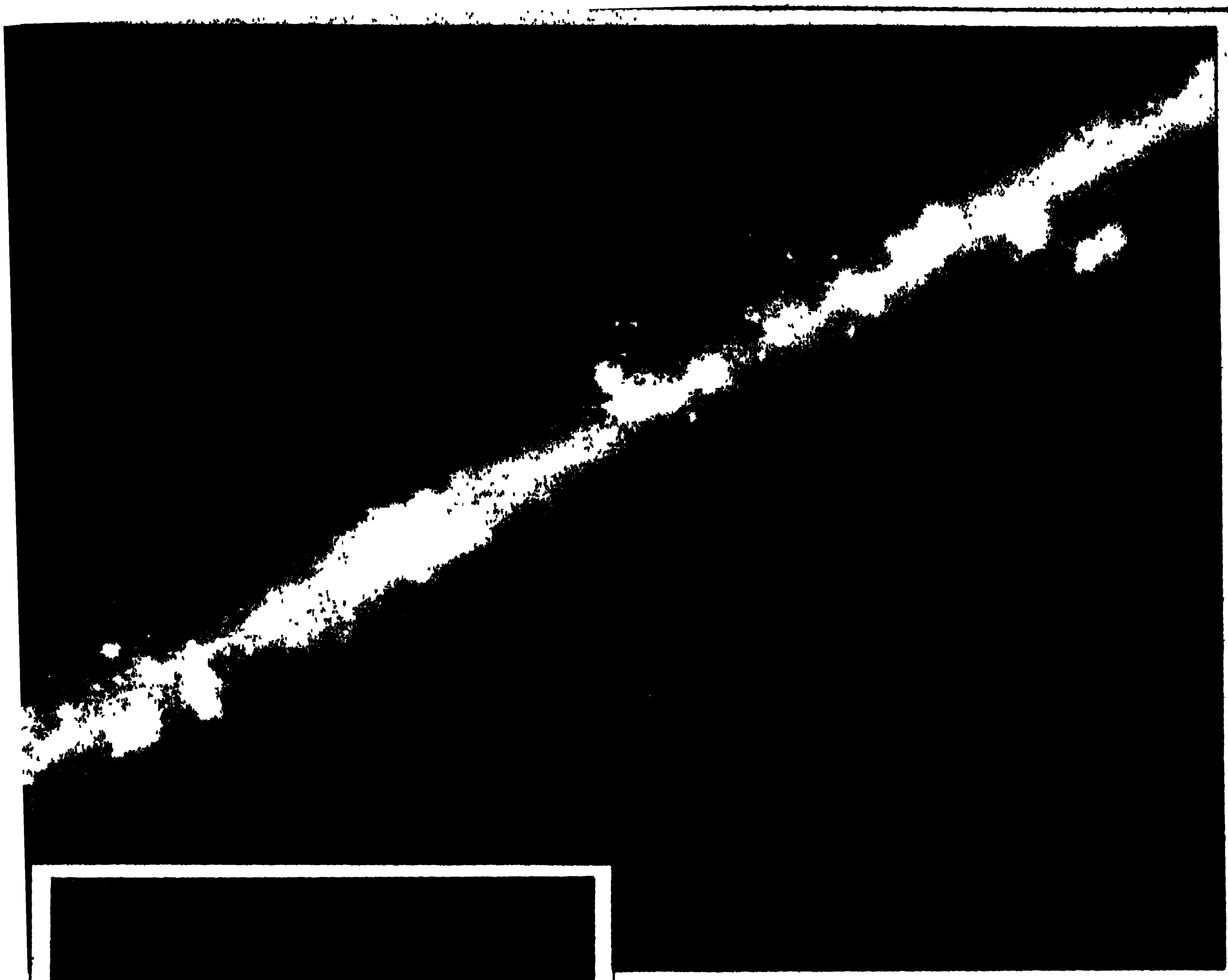
"I wonder how many miles I've fallen by this time?" she said aloud. "I must be getting somewhere near the centre of the earth.. "

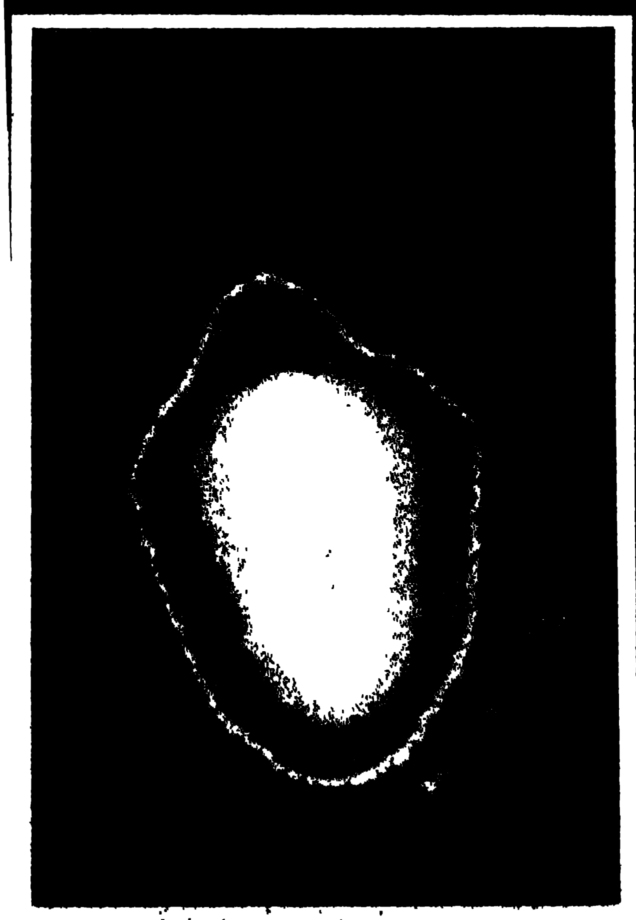
—**Lewis Carroll**
Alice s Adventures in Wonderland

A JOURNEY to the centre of the Earth is the stuff science fiction is made of So is the journey to the centre of our galaxy at least as of today But that space odyssey seems less improbable than a journey to our roots For thanks to the Infrared Astronomical Satellite (IRAS) we at least know what the heart of the galaxy looks like an iridescent slash of gas and dust lit by unseen suns, etched across the mysterious purple of the cosmos *(see picture above right)*

It s one of the most remarkable pictures ever produced a view doubly precious For it is obtained not by visible light but by warmth by infrared radiation to which human eyes are blind The Earth s atmosphere compounds our blindness Water vapour blocks all but a few select photons of the infrared signals from space Says pioneer rocket astronomer Herbert Friedman The air above us makes life livable and comfortable but it blinds the astronomer to all but a very limited view of the universe It seems particularly frustrating that radiation that had travelled billions of light years could be lost in the last thousandth of a light second, barely a hundred miles from completing its journey to Earth

Infrared observations are extremely valuable to the astronomer For unlike starlight, infrared waves can pass virtually unimpeded by dust in the interstellar medium. Moreover, many types of astronomical objects radiate a

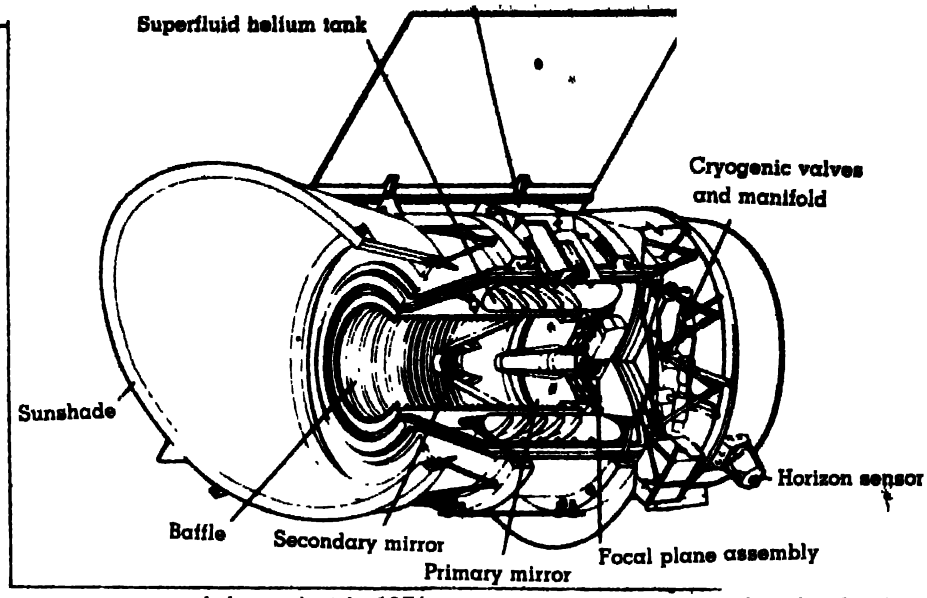




large fraction of their total luminosity in the infrared region. This is particularly true of bodies with low temperatures. For everything in the universe, be it a dust mote or giant gas cloud (or even the universe itself) which bears even the slightest heat, even if it is only a few degrees above absolute zero, radiates some infrared waves. This non-luminous matter of the universe includes asteroids, planets, protostars, interstellar molecules and interstellar dust grains. Says Mitchell Waldrop in *Science:* "This 'cold' component of matter is probably at least as important in the universe as the luminous stars: indeed, during the last decade infrared astronomy has become one of the most active subdisciplines in the field. Unfortunately *(as said earlier)*, infrared photons are strongly absorbed in the earth's atmosphere." Moreover, there is the problem of thermal emission from the atmosphere and the telescope itself. This heat noise readily drowns the faint IR emanations from space.

The galactic centre of the Milky Way* (above) *as viewed by the Infrared Astronomical Satellite (IRAS). The bulges and blobs are giant clouds of gas heated by nearby stars.* Left: *IRAS discovered this comet, IRAS-Araki-Alcock, within 5 million kilometres of the Earth. The false colour image, detected at a wavelength of 25 microns, clearly shows the shrouds of particles around the core.* Far left: *A unique picture of the constellation Orion, probably the first view of the entire formation

IRAS IN WONDERLAND



The solution: IRAS, a satellite telescope chilled with liquid helium to detect faint emanations of heat or infrared radiation from the universe.

By all accounts IRAS was a technological triumph. Its telescope was chilled to below 10°K to control its own internal heat emissions. To maximise sensitivity, its focal plane instrumentation was cooled to ~2.5°K and the data it gathered in its 10-month "successful odyssey" is bound to keep an army of scientists busy for several years. The findings will sharpen our sights and may even revolutionise our thinking about the universe.

The portrait of the universe thus revealed *is* cold and dusty. But only to the trained eye. In the false colours of the computer palette, a cold-cored comet found by IRAS *(see previous page)* looks as colourful as an Easter egg (or a red hot fireball)!

Through the "cold" eye of IRAS is evoked a vision of wonderland, of vistas unseen before by human eyes—dust in myriad incarnations—curls, wisps, spumes, knots and awesome cirrus clouds scattered in the chill depths of interstellar space: dusty cocoons warmed from within by whole hives of nascent stars; new comets and asteroids rushing pell-mell through a dust-spattered solar system; mysterious galaxy-like "objects" radiating 100 per cent as much heat as light; and above all rings, rings of dust and debris around stars other than our own Sun No other finding has excited public imagination as much as this. could these rings coalesce into future worlds (as ours did once upon a time)?

IRAS observed all this from its 900-km near-polar orbit, safe from the heat interference of the atmosphere below The $180 million satellite, a joint venture of the United States, the Netherlands and United Kingdom, was launched on 26 January, 1983 to complete the first all-sky survey at the infrared wavelengths between 8 and 119 microns.

When work began on the IRAS in the mid-seventies the challenges faced, technological and financial, were enormous. NASA started the project in 1974 inspired by a short-lived cryogenically cooled satellite launched by the Air Force. It had the state-of-the-art expertise in key areas like infrared detectors. But it was beginning to feel the pinch of the costly space shuttle development programme.

Enter NIVR, the Netherlands aerospace agency. Flush with oil money following the 1973-1974 oil embargo (Netherlands' refineries process most of Europe's imported oil), the Dutch Government was planning an infrared satellite (as a sequel to a small cosmic-ray/ultraviolet observatory known as the Astronomical Netherlands Satellite). A collaboration was inevitable. Within a year a joint working group began the conceptual designs.

The British joined shortly thereafter. The final shares were as follows: Britain, a 10% partner, built the IRAS ground station (at Chilton, South of Oxford) from which they would operate the satellite and collect its data once it was in orbit. The Dutch, 40% partners, made the spacecraft with its associated systems of communications, pointing and power. The Americans, 50% partners, built the telescope, the detectors, the cryogenic system, the launch vehicle and the scientific data processing.

"The programme faced problems that were just continuous," says Project Manager Gerald Smith of the Jet Propulsion Laboratory. "For a time we thought there'd be no end to it." After two years of delay, IRAS (described as one of the most frustrating and difficult projects ever attempted) was finally launched into polar orbit from the Vandenburg Air Force Base in California by a McDonnell Douglas Delta 3910 launch vehicle.

Once in space, at an altitude of 900 km, the satellite began to perform flawlessly. One week after launch, on 1 February, 1983, the satellite ejected its telescope aperture cover, exposed its helium-chilled sensors to the sky and began taking data at the rate of 700 million bits per day...

The heart of the satellite is the telescope (f/9.6 Ritchey-Chretien design with beryllium mirrors and a 57-cm aperture). The telescope focuses the incoming infrared radiation on an array of 62 solid-state chips which produce an electrical signal in response to heat. These infrared detectors, each a rectangle less than a centimetre across, observe radiations ranging from eight to 119 microns. (The band width from 8.5-15 microns is observed by 15 silicon-arsenide chips; the 19-30 micron range by 16 silicon-antimonide chips. Of the 31 germanium-gallium detectors, 16 scan in the 40-80 micron range while 15 detectors are designed to survey the 83-119 micron spectral range.)

"These four infrared wave lengths correspond to temperatures between the freezing point of water and about 20 degrees celsius above absolute zero—the very temperature range in which lie planets,asteroids and instellar dust clouds (or 'cribs') where baby stars are born," says Gerry Neugebauer of Caltech, Leader of the IRAS Science team. "(So sensitive is the cold eye of IRAS) that it can see the heat of a dust mote two miles away, or of a baseball across the continent."

The IRAS mission can be viewed as a sort of Dewar's* dream come true: it's

** After Sir James Dewar, Scottish inventor of a double-walled thermos "flask".*

The most celebrated discovery of IRAS concerns the so-called ring of Vega—the first known example of a star other than the Sun orbited by solid particles.

the largest thermos bottle ever to fly! The doughnut-shaped tank which surrounds the telescope was filled at launch with 72 kg. of superfluid helium. "This is the first time helium has been used in a satellite experiment resulting in by far the lowest temperature of operation of any instrument in space," says the report by the IRAS team in *Nature*.

The superfluid helium was indeed the lifeblood of the mission. It boiled off into space through a porous stainless steel plug. (2.4 cm diameter) on the top of the tank. In the process the vaporised gas chilled the liquid helium and carried off the heat from the container and the focal plane into space. According to original estimates, the helium supply was expected to be exhausted by six months. However, it lasted for ten months by which time 95 per cent of the sky had been scanned at least four times and 72 per cent had been surveyed six times.

Scientists who were hoping that the helium would last till 4 January were surprised when on 21 November, the supply of superfluid helium fell from standard rate of flow to zero in a matter of seconds. Until the very last minute the telescope was operating normally. As the helium dregs boiled off, the remaining fluid spread in a thinner and thinner coating that still cooled the telescope. As *Discover* put it, " IRAS was good to the very last drop"!

After the cryogen was depleted, the focal plane temperature began to increase at a rate of about two-tenths of a degree centigrade per hour. As the detectors began to go blind, project engineers tried to continue to collect data with the remaining detectors until the temperature rose to −260°C. "By then, however, the science goals had been accomplished," says Charles A. Beichman, member of the IRAS Science team. "It will be a frustrating footnote that we didn't actually get everything (about 5 per cent of the sky remained to be surveyed when the helium was exhausted), but we have certainly gained more than we could have hoped for before the launch."

Barely one per cent of the data collected by IRAS has so far been analysed. It reveals view of the universe that is startlingly different from the one shown by visible light.

For one thing, it is a far dustier and enormously more fecund place. "In fact, the satellite uncovered so much dust and debris, the cumulative mess may force astronomers to recalibrate cosmological distances," says Frank Low of the University of Arizona. "Estimated distances to certain heavenly bodies are based in part on their brightness: The dimmer they are the farther they are assumed to be. But if considerable dimming is caused by heretofore invisible dust, these objects are probably much closer."

On the very first day of its operation, IRAS detected about 4,000 infrared sources. This is approximately equal to the number of sources known in the *entire* sky before the satellite's launch.

By end of mission the "cold eye" of the satellite had pinpointed over 2,00,000 infrared objects in space. "It had discovered and made detailed observation of five previously unknown comets, four new asteroids, and an enigmatic comet-like object apparently the source of orbiting debris that causes the yearly Geminid meteor shower on Earth. When IRAS made a broad sweep of the solar system to estimate the total number of asteroids, it counted about 20,000, some four times the number previously described," reports Michael Gold in *Science-84*. IRAS also discovered a band of dust around the Sun between the orbits of Mars and Jupiter.

The most celebrated discovery of IRAS concerns the so-called ring of Vega—the first known example of a star other than the Sun orbited by solid particles. Also called Alpha Lyrae, Vega, 60 times more luminous than the Sun, is 26 light years away from the Earth in the Milky Way galaxy. It is one of the most studied stars in the sky but it was only during an IRAS sighting that two American astronomers, George Aumann of JPL and Fred Gillette of Kitt Peak National Observatory, noticed that Vega was unusually bright in the infrared region. The "bump" its radiation was producing on the charts at Chilton was "too fat" for its size. The astronomers deduced that the extra heat was coming from a ring of pebbly material some 80 astronomical units (Earth-Sun distances). By contrast the solar system of the Sun is 40 astronomical units.

Aumann and Gillette determined that the particles must be larger than cosmic dust grains, of size 1 mm and more (even tens of kilometres). Anything smaller would have been drawn back into the star by gravity. The discovery of the ring was verified by a team of astronomers from Texas University who used an infrared telescope aboard a Lockheed aircraft (NASA's Gerard P. Kuiper Airborne Observatory).

The question that excited layman and editorial writers alike was: could a planetary system be born out of this ring of dust and debris? It seemed unlikely. For calculations showed that Vega would reach the end of its "main sequence" lifetime *before* a planetary system could evolve (assuming the existence of conditions suitable for such evolution).

Some months later, scientists announced that a second star, Fomalhaut, the brightest star in the constellation of Southern Fish, Piscis Austrinus, was also apparently surrounded by an orbiting collection of dust and debris. Fomalhaut is twelve times more luminous than the Sun and one-fifth as bright as Vega. With a lower surface temperature than Vega (8,800 K compared with 9,600 K), Fomalhaut should have a longer lifetime, although IRAS astronomers are as yet unable to provide numbers, according to a report in *Nature*. The star, which is 22 light years from Earth, has a dust shell about 100 astronomical units.

Excited by these findings, scientists began a search for stars that were too bright for their actual size. Out of the 9,000 stars examined, Gillette has short-

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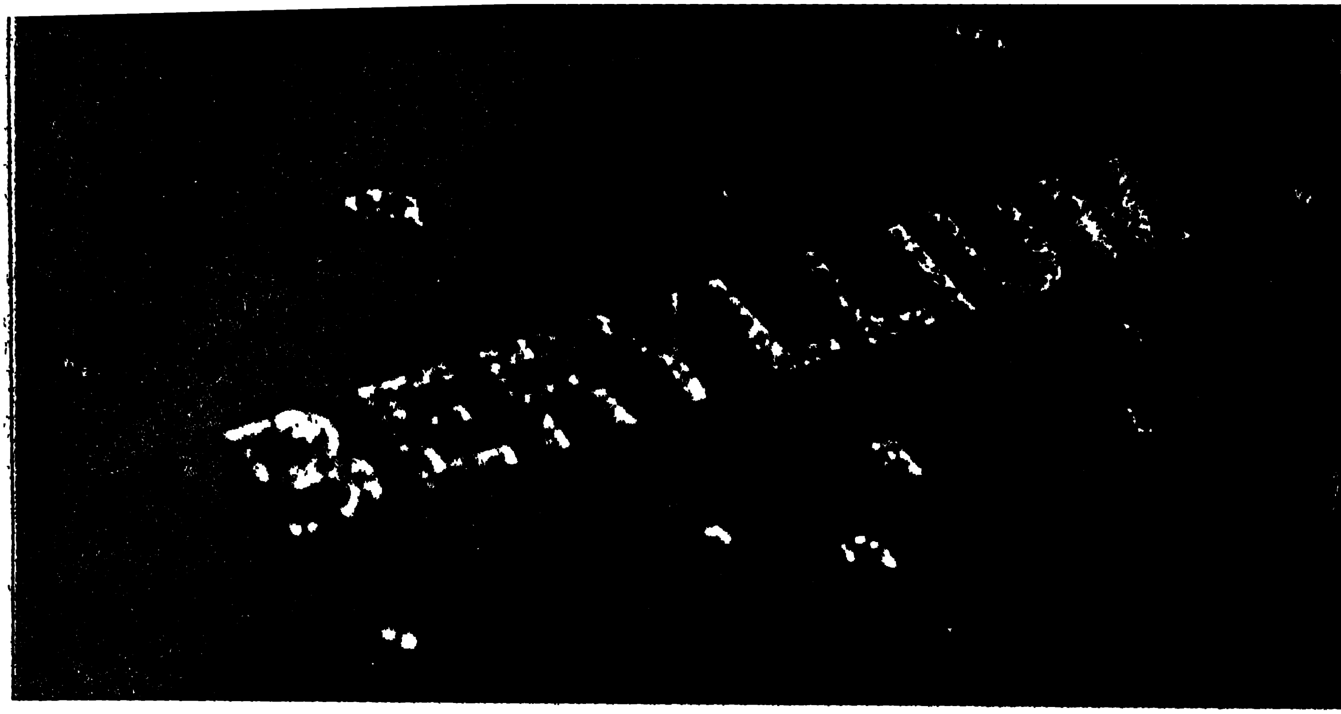


GEM OF A METAL

H. S. Ahuja

GREEN emerald, bluish-green aquamarine, rosy Vorobyevite, yellowish green beryl, wine coloured heliodor, crystal clear phenakite, delicate blue euclase, chameleon-like chrysoberyl—from times immemorial the stones have complemented the beauty of women, enhanced the splendour of kings. Wars have been fought over these coveted stones which have always been eagerly sought by sovereigns and subjects alike. In the world of tomorrow too these gems are going to be precious. But for a different reason. For they constitute the ore of a very important metal—beryllium. Although one of the lightest metals, beryllium is a heavyweight when it comes to its utility.

This metal of the future has a very illustrious past. More than 2,000 years ago, Queen Cleopatra is said to have owned large emerald mines in the lifeless Nubean desert. The Roman Emperior Nero too had a penchant for the green gem and loved watching the gladiators fight through a large emerald crystal.

However, the element beryllium itself was discovered in 1797 by Vauquellin. In French, the element was referred to as glueinuim (Gl), because of the sweetish taste of many of its compounds. Later Wohler and Bussy in 1828, produced metallic beryllium in the form of impure powder by reducing beryllium chloride with metallic potassium. They named the new metal beryllium (Be) which was officially recognised in 1957. During the nineteenth century numerous other investigators contributed to the development of chemistry of beryllium. Of particular interest is the work of French scientist, Lebeau, who in 1899, obtained small hexagonal crystals of beryllium by electrolysis of sodium beryllium fluoride and later prepared beryllium-copper alloy by direct reduction of beryllium oxide with carbon in the presence of copper. Commercial development of beryllium in United States was begun in 1916 when first significant beryllium metal ingot was produced. In 1932 beryllium copper master alloy was made available commercially.

But the element was still unknown until the late 18th century. Many scientists had attempted analysis of beryl, however no one could detect the metal contained in it. It looked like the element was hiding behind the back of aluminium and its compounds—its properties were strikingly similar to those of aluminium. But there were also differences. The French chemists Nicolas Louis Vauquellin was the first to notice the essential differences. He reported on 15 February, 1789, that beryl and emerald contained a new "earth" different in properties from alumina—aluminium oxide. He persisted with the efforts and ultimately identified the new element eight years later.

Among the thirty odd recognised minerals containing beryllium, only three are significant. beryllium ($2BeO. Al_2O_3. 6SiO_2$), phenacite ($2BeO. SiO_2$) and bertrandite, ($4BeO. 2SiO_2. H_2O$). Of these beryllium, a complex beryllium aluminium silicate containing about 11-13 per cent BeO is commercially important.

The metal is widely distributed and estimated to be about 0.001 per cent of earth crust. India, Brazil, Argentina, Canada, United States, Congo, South Africa, Uganda and USSR are principal producers of beryl ore. Low grade bertrandite (0.6 to 0.9% BeO) is now also being processed in USA. Hand picking is the only commercial method for concentration of this ore and therefore is limited to large crystals of beryl. Gigantic crystals of beryl occur naturally. They may weigh tens, hundreds or even thousands of kilograms. One of the biggest crystals known is nearly 9 metres long.

Beryllium metal is commercially produced entirely by the reduction of

beryllium fluoride by metal magnesium. For obtaining beryllium with higher purity fused salt electrolysis of beryllium chloride is a preferred route.

Magnesium reduction of beryllium fluoride is carried out in a graphite lined furnace at approximately 900°C using excess of beryllium fluoride. At this temperature the reduction product, beryllium, is in the form of powder intimately mixed with the slag. In order to consolidate the metal powder, the temperature of the reduction charge is rapidly raised to about 1400°C and it is poured into a graphite receiver mould. This is then wet-ball-milled to obtain beryllium metal in the form of pebbles.

In the electrolytic reduction method, the process is carried out in a nickel crucible, which acts as the cathode while a high density graphite rod placed in the molten metal mixture acts as an anode. The beryllium metal gets deposited on the crucible walls in the form of flakes.

Both the processes yield acceptable products, however, the metal is contaminated either with slag or electrolyte salt. It is therefore not suitable for direct production of powder and is further purified by vacuum induction melting. The metal thus obtained is 96 to 99.5 per cent pure.

Beryllium metal with its melting point of 1283°C should present no problems to melt or cast. However, the cast beryllium metal exhibits essentially no ductility at room temperature. In order to overcome this problem powder metallurgical techniques are adopted to produce fine grained material. The vacuum melted beryllium metal ingot is converted to powder form by mechanical attritioning. It is then consolidated to near theoretical densities by a variety of techniques. Among these the vacuum hot pressing is the most commonly applied technique. Most beryllium parts produced today are machined from vacuum hot-pressed blocks.

Beryllium with an atomic number 4 and an atomic weight 9.013 (chemical scale) lies in the first short period of the Periodic Table. It heads Group IIA which includes magnesium, calcium, strontium, barium and radium. However, it is much closer to aluminium by nature of its chemical properties. Like aluminium, beryllium forms a protective oxide skin and its stability in air, even at red heat is due to this protective oxide layer. Nitrogen attacks beryllium at temperatures above 900°C forming beryllium nitride. Beryllium reacts readily with sulphuric, hydrochloric and dilute nitric acid. Alkaline solutions react with beryllium with evolution of hydrogen gas.

The similarity between Be & Al caused quite a bit of trouble to the author of the periodic table Mendeleev. Because of this similarity in the middle of the 19th century beryllium was considered to be a trivalent metal with an atomic weight of 13.5 and consequently should have occupied in the table a place between carbon and nitrogen. This introduced obvious confusion in the regular change of properties of elements and cast a shadow of doubt on the validity of the periodic law. Mendeleev, however, was convinced of his law and hence placed beryllium in the second group with an atomic weight of 9. Later Swedish chemists Nilson and Peterson found this to be correct.

Beryllium can form polymeric compounds as well as a class of covalent compounds which show remarkable thermal stability. Some can be distilled at temperatures above 300°C at atmospheric pressure without decomposition. Example of these compounds include the basic beryllium carboxylates, $Be'O(RCO_2)_6$ and neutral chelate compounds of beryllium such as the well-known beryllium acetylacetonate which is volatile, melts at 108°C and boils undecomposed at 270°C. Beryllium alkyls prepared by reacting Grignard reagents with beryllium chloride, have been shown by X-ray diffraction studies that they form a polymeric chain in which each beryllium atom is attached tetrahedrally to four carbon atoms and each carbon atom to two beryllium atoms. The structure of solid

"Birth" of Beryllium

There are two processes for obtaining BeO from Beryl:-

Fluoride process: This involves the sintering of beryl ore with sodium silicofluoride and sodium carbonate at about 800°C. In an improved process sodium ferric fluoride is used instead of sodium silicon fluoride. The sintering reagents selectively attack the beryllium values of the ore, and the water leach liquor is relatively purer. Thus beryllium hydroxide is precipitated by sodium hydroxide without any additional purification step.

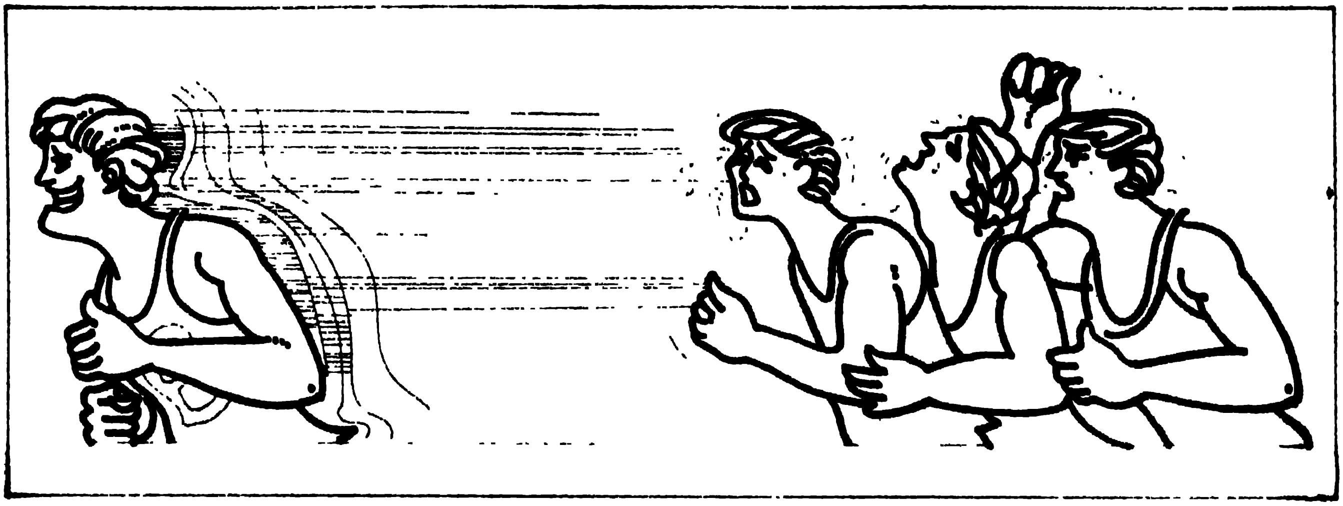
Sulphate process: In this process the beryl ore is given the thermal treatment to destroy its original structure because of its refractory nature. This is done either by heating it to molten state (~1800°C) and quenching in water or by [illegible] the ore with alkaline earth carbonate [illegible]. This treatment [illegible] ore [illegible] which is then [illegible] acid. The sulphate liquor is [illegible] and is subjected [illegible] prior to precipitation as [illegible]

Among the two processes, the fluoride process is simpler in operation and less capital intensive.

Beryllium halide intermediates: The beryllium hydroxide produced by one of the above methods is converted to anhydrous beryllium fluoride or chloride for metal production. For the production of anhydrous beryllium fluoride, the beryllium hydroxide is dissolved in ammonium bifluoride to produce ammonium beryllium fluoride. The double fluoride is purified by standard precipitation procedures and then is crystallised. The crystals are thermally decomposed at 800°C to obtain anhydrous beryllium fluoride. Beryllium chloride is produced by the chlorination of beryllium oxide and carbon mixture at 1000°C. Beryllium chloride distills away from the chlorinator and is collected in a condenser. This beryllium chloride is further purified by re-distillation at about 800°C in a stream of hydrogen.

H.S.A.

Beryllium has high fatigue resistance



dimethylberyllium is that of an electron deficient compound:-

It is of analytical importance that beryllium does not react strongly with the universal complexing agent ethylenediamine tetraacetic acid (EDTA). In the analysis of beryllium using selective pH many interfering metal ions are chelated by EDTA while beryllium is precipitated as hydroxide or beryllium ammonium phosphate.

Properties and uses

The uses of beryllium mainly stem from its nuclear and thermal properties. It is an excellent reflector of neutrons, returning them to the insides of an atomic reactor. The leakage of neutrons is thus prevented. Coupled with its high radiation resistance this property makes beryllium a darling of the nuclear engineers. Although its large scale use in power reactor has waned due to the *helium embrittlement problem*, it is still being used as a reflector material in research and fast reactors Beryllium by virtue of its light weight is a potential material for compact reactors required for spacecrafts submarines or ships. When beryllium atoms are bombarded with alpha particles from radium, the nucleus yields a profusion of neutrons. It is, therefore, used as a source of neutrons for the start of nuclear reactors and in classified weapon programmes.

Beryllium is strong, stronger than structural steel. Besides, it has an exceptionally high melting point compared to Magnesium or Aluminium. This, along with its high thermal conductivity, high specific heat as well as resistance to heat makes it possible to use beryllium compounds as a heat-sink material especially in light weight, high performance aircraft brakes and missile re-entry vehicles. The metal is also used for making rocket engine nozzles, switch gear components, etc.

Parts made from beryllium are capable of maintaining high precision and stability of dimensions. This makes it an ideal material for precision navigational aides for aircraft, spacecrafts, missiles and submarines. Beryllium is also considered an important material for space optics. Along with other properties of beryllium its ability to accept optical polish are very important considerations in both scanning mirrors and large mirror components of satellite optical systems.

Because of its properties beryllium is an ideal choice as a structural material in the aerospace programme. Theoretical weight saving that can be achieved by using beryllium may range for 30 to more than 60 per cent depending upon the structural material.

Beryllium possesses an excellent resistance to metal fatigue and corrosion. It can also retain its elasticity over a wide range of temperatures. While automobile springs made of ordinary carbon steel break after 800-850,000 impacts, beryllium springs can withstand 14 million impacts without any signs of wear-and-tear.

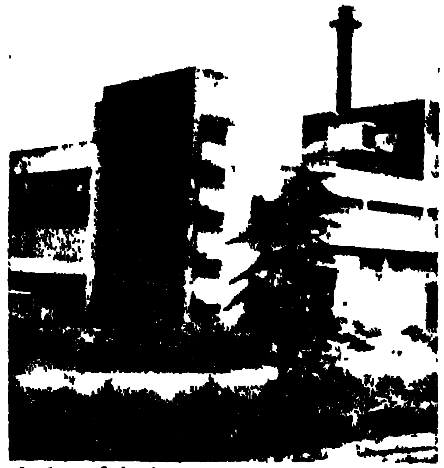
Most metals tend to absorb X-rays and hence can best be considered translucent. But beryllium is transparent to X-rays and transmits them some 17 times more efficiently than aluminium. Hence it is increasingly used for the construction of windows for X-ray tubes

Beryllium oxide is used in the manufacture of high-temperature refractory material and high quality electrical porcelains such as aircraft spark plugs and ultra high frequency radar insulators. It also finds use in electrical and electronic fields. Graphite crucibles are coated with beryllium oxide to avoid contamination of melted alloys with carbon. Beryllium oxide crucibles are used where exceptionally high purity and reactive metals are being melted.

Beryllium metal powder has one of the highest heat of reaction of any element; it may be mixed with oxidizers and binders in liquids, solid and hybrid type of high-energy propellants. Solid propellant motors containing fuel mixtures of beryllium have been made. Promising applications of beryllium are in high speed process machinery for stiffening other metals or plastics in composites and as cryogenic conductor for transmission of electrical energy.

One of the most exotic future application of beryllium is for making implantable light weight artificial heart, driven by a thermionic generator.

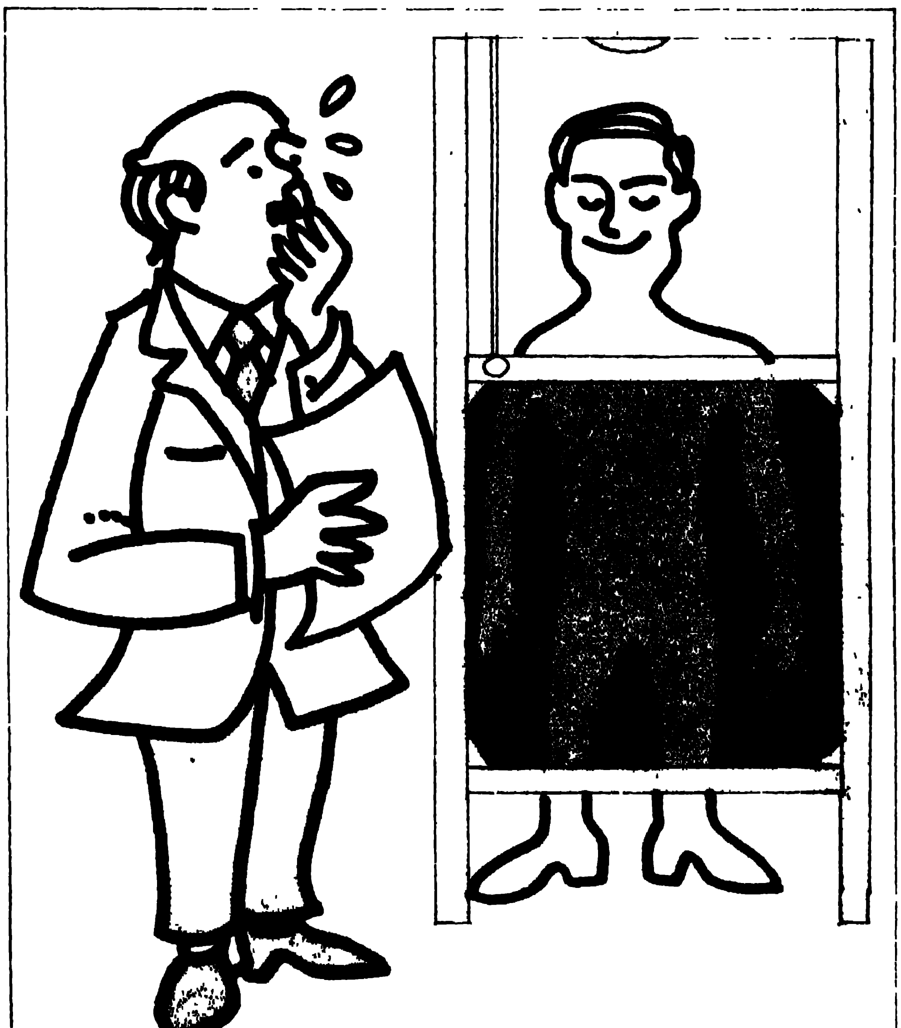
Cu-Be alloys have unique characteristic that lead to a variety of applications. The most important are high electrical and thermal conductivity and the ability to be precipitation hardened to high tensile strength. The important Cu-Be alloy is one which contains about 2% beryllium and 0.25% cobalt. The alloy is ductile and when heat treated attains great strength.



A view of the beryllium plant at Vashi, New Bombay

Toxicity

Recently, some of the ailments of those working with beryllium have been specifically attributed to contact with beryllium and its compounds. The term 'berylliosis' is used for this. Acute berylliosis causes irritation of the respiratory tract with pneumonitis. The symptoms for chronic berylliosis are less clearly defined; they usually involve loss of weight and appetite, coughing, weakness etc. However, safe procedures have been developed to protect those working with beryllium so that its toxicity need no longer affect the workers and hinder manufacture and fabrication.



Francis D sa

Beryllium is highly transparent to x-rays

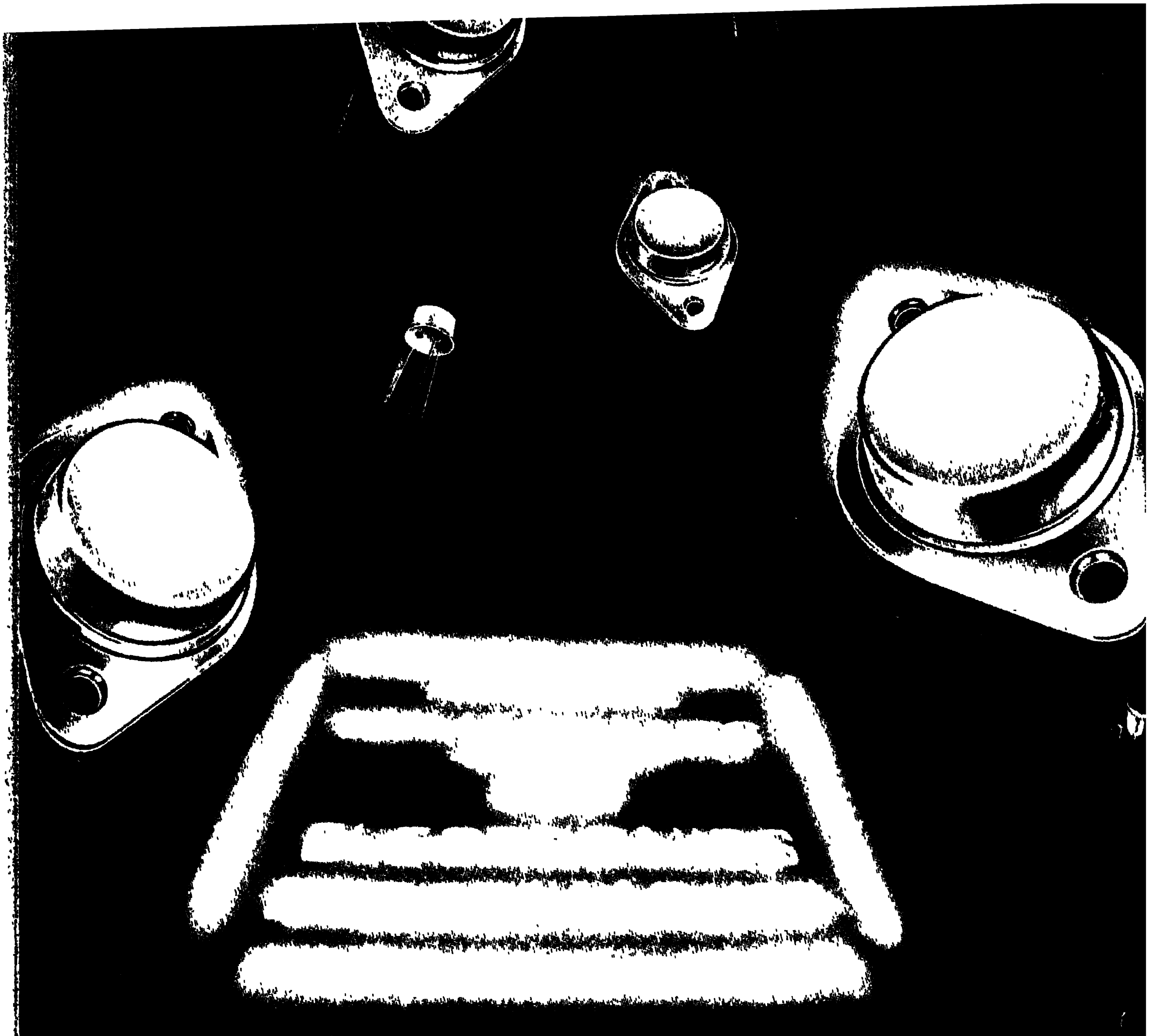
The Indian scene

India is among the few countries having fairly large deposits of the mineral beryl. Definite demands for beryllium metal and its alloys and other beryllium compounds have been identified in the country's programme in space science, nuclear engineering, electronics and other allied branches.

Considering the raw material resources and potential demand for beryllium products, research and development programme was undertaken several years ago at the Bhabha Atomic Research Centre with a view towards creating a base for the production and fabrication of beryllium metal and beryllium copper alloys. Investigations have also been carried out on the sintering of beryl ore with sodium silicofluoride at the National Metallurgical Laboratory and on the preparation of beryllium metal by the electrolysis of beryllium chloride at Institute of Science, Bangalore

Fluoride process for ore processing was chosen over the sulphate process, for its techno-economic advantages. Magnesium reduction of beryllium fluoride was adopted as the process capable of producing beryllium metal and copper-beryllium master alloys. In a special laboratory set up with all recommended safety measures, extensive investigation aimed at optimising the process parameters of each step of the process were carried out. These formed the basis of a pilot plant which has now been set up at Vashi, New Bombay to produce vacuum hot pressed beryllium blocks and copper-2/beryllium alloy ingot for catering to the immediate domestic need. The beryllium programme in India is poised for steady growth

Dr H S Vhuo is Scientific officer with the Chemistry division of BARC, Trombay, Bombay



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IRAS IN WONDERLAND

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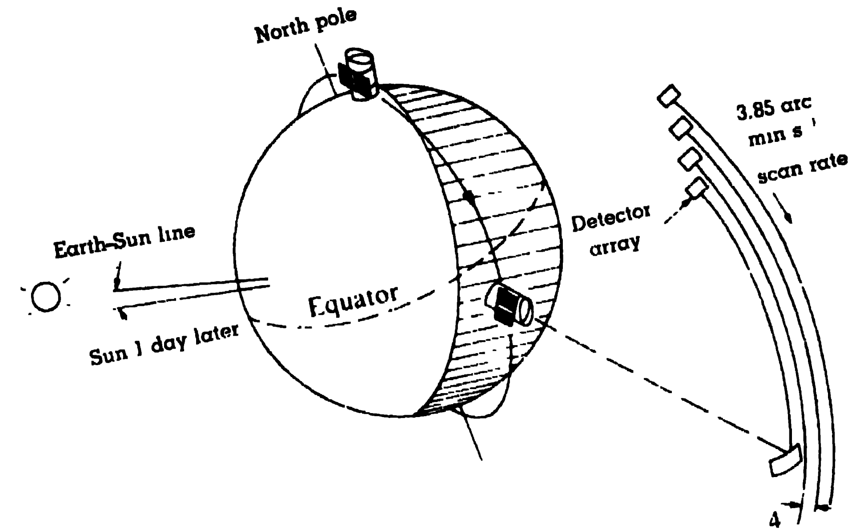


How to beat the heat? The orbital height of 900 km and inclination of 99° coupled with the Earth's equitorial bulge lead to an IRAS orbital precession of 1° day⁻¹. Thus the satellite always keeps in the twilight between sunlit and darkened portion of the Earth. Also by pointing the satellite radially away from the Earth the cold telescope is more easily shielded from the heat loads of the Sun and Earth while providing a natural scanning motion across the entire sky in about six months

listed about 50 candidates for deeper study.

Dutch astronomers who studied the IRAS data, found three partial shells of material around the hoary star Betelgeuse. Also known as Alpha Orionis, this star is nearing its end as a red supergiant According to Harm Habing, an astronomer from Huygens Laboratory in the Netherlands, the shells were formed during the stellar blow-ups and collapses that Betelgeuse witnessed during the last 1,00,000 years Parts of the shells were lost due to interstellar drag exerted by cosmic dust and gas Incidentally, the name Betelgeuse is probably derived from an Arabic phrase meaning "the Giant's (Orion's) shoulder'.

In the dark reaches of interstellar space, IRAS also revealed large collections of graphitic dust. Called cirrus clouds because of their resemblance to the wispy, high-altitude clouds on Earth, these were described as "a new component in the galaxy, not suspected before" by IRAS Science Team Chief Neugebauer. Because graphite absorbs heat more readily than ordinary silicate dust (of which the inner planets are made), these cirrus clouds were found to be quite warm—some 35 degrees Celsius above absolute zero.

Heat also was the tell-tale sign of small clouds of dust that hid within their hearts baby stars. These so called Bok Globules which dot the Milky Way were earlier thought to be too puny and cold to sire stars. But the sensitive "eye" of IRAS did respond to the stirring warmth of nascent stars within them. Many of these stellar nurseries, dense masses of gas and dust, are normally invisible against blackness of space. But brightness in the infrared region gives them away. IRAS found signs of star formation in one-third of the small dark, clouds previously thought to be dormant!

An important example of the new nurseries is a small cloud called Barnard 5. IRAS found in it four new sun-like stars. One of them was roughly of one solar mass. Newborn stars previously reported have all been further away than Barnard 5 or much, much larger than the Sun. Says Thomas Soifer from the California Institute of Technology: "Although to some extent we are seeing what we expected to find, we are seeing lots of new regions of star formation within our own galaxy, including some we only suspected before."

Our Milky Way galaxy generates about one new star a year and gives out equal amounts of infrared heat and visible optical energy. But IRAS found that our nearest neighbour (and similar) Andromeda galaxy puts out only three per cent of its energy as infrared radiation. Infrared luminosity is usually a good indicator of the rate of star formation. Thus our galaxy is obviously more fecund than Andromeda. But the question Soifer asks is: "Why do apparently similar galaxies have different IR rates?"

Indeed, IRAS detected galaxies that put out ten or even 50 times as much heat as light. Is it because they are spawning new stars at an enormous rate? According to Soifer, some of these prodigious emitters appeared skewed and had peculiar shapes, indicating that they have been affected by neighbouring galactic gravitational pulls. That in turn could have set off an inner collapse leading to a frenzy of star formation in the mass being compacted.

More intriguing were mysterious galaxy-like objects that apparently had the temperatures of galaxies but seemed to be radiating more than 100 per cent as much infrared as optical energy "But the IRAS has no way of determining how far beyond the solar system these unidentified objects are," reports *Discover*. "They could be common little dwarf galaxies, very close.. that wouldn't amount to a hill of beans, or they could be very distant galaxies."

This only illustrates the point that the infrared sky is unexpectedly more complicated. "On a given day, the IRAS detector array would generate 100,000 detections per day," says John Duxbury, Coordinator of the data processing effort from JPL 'And only 20 per cent are real, stationary sources you want to retain." As said earlier anything can cause a blip in the detectors stray moonlight, giant gas clouds, errant satellites, even dust motes knocked off from the IRAS solar panels by micrometeorites' It is problem described as an "embarrassment of riches" (which, incidentally, required 100-man years of software development at the processing faculty)

For all that nightmarish' amount of data generated by IRAS, the astronomers are only hungry for more NASA is planning a more powerful infrared telescope the Shuttle Infrared Telescope Facility (SIRTF), which will be flown in the 1990s. However, you will still be hearing a lot from the canned tapes of the IRAS over the next several years... ❑

BECAUSE MATHS IS FUN

PHOTOGRAPHS BY R. Y. DUNDAPPA

A section of the participants of the "Maths Olympiad-84" held at the Indian Institute of Technology, Bombay, in February

OLYMPIC games, summer and winter, are held every four years. The disabled have their own Olympics. There are also chess Olympiads. But are you aware of a 'Maths Olympiad'?

"The Mathematical olympiad" has evolved from the Eotvos competitions, the first of which was held in 1894 by the Mathematical and Physical Society of Hungary in honour of its founder and president, the physicist Baron Lorand Eotvos (SCIENCE TODAY, January 1980, p. 55). These contests, with a slightly different name, are held every year and the first place in the 24th International Mathematics Olympiad held in Paris recently was won by a six-man team from the Federal Republic of Germany. The team was followed by the US, Hungary, the USSR and Romania. What about India's participation?

For a country which so proudly talks about its contribution to the development of the mathematics in ancient times, we are nowhere near the international scene. Even at the national level, there are no concerted efforts made so far to hold such an event. Only at a regional level, the Mathematics Association of the Indian Institute of Technology (IIT), Bombay, conducts "Maths Olympiad". Why does mathematics elicit such a lukewarm response in our country?

This may be the result of a wrong but popular notion that mathematics is a dry and dull subject that racks the brain rather than stimulate it One of the objectives of the IIT Maths Olympiad is to set right this wrong thinking and to cultivate interest for the subject among youngsters.

Surprisingly, the event has received overwhelming response and over the years the number of participants have increased substantially. In 1979, when the Olympiad was held for the first time, 425 students participated. This year, when the contest was held at IIT, Bombay, in February, there were more than 1,000 participants. Clearly, the youngsters are interested in mathematics and are eager to make their presence felt at international levels. Thus, to some extent, the objective of organising the event has been achieved.

The "Maths Olympiad" also aims at discovering mathematical talents among students in and around Bombay. The thrust of the test is to assess how fast and accurately a participant is able to apply the basic principles of mathematics to the problems given. The problems are chosen from basic calculus, algebra, geometry, set theory and elementary probability theory

The test consists of 50 objective type questions with multiple choice answers to be solved in 90 minutes. There is a scheme of negative marking for wrong answers. This is to discourage the tendency of illogical guess work. A right answer carries two marks, a wrong answer one negative mark and the unanswered question carries zero mark. With the consent of the organisers, we reproduce here the 12 most interesting questions from the recent Olympiad. We have avoided the multiple choices to enable you to arrive at a correct answer using the correct method. Try and solve the questions and see where you stand. Answers with necessary hints are given on the next page in reverse.

1. There are 11 numbers. The average of the first six is 70 and the last six is 80, while the average of the first five is 80 and that of last five is 76. What is the average of all numbers?
2. A circular fort of diameter 6 km has two gates only. One in the north and the other in the south. A great Oak tree is standing 2 km north of the north gate. What distance must be covered by a soldier walking east from the south gate to see the Oak tree, without obstruction?
3. A vessel contains a mixture of wine and water. Had there been a gallon more of wine and a gallon less of water, the ratio of wine to water would have been 7:8; but had there been a gallon more of water and a gallon less of wine, this would have been 2:3. What was the original mixture in gallons?
4. Mr. G. Mohan lives in a bungalow with his cousin and 4 servants A, B, C and D. One day he finds that a sum of Rs 100,000 is missing from his locker. After considering the situation he concludes: 1. If A is a thief, then B must also be one. 2. It is not possible that both B and D are responsible for stealing the amount 3. If D is not responsible for the theft then C must be the thief. 4. If his cousin is not a thief, then either A or C must be 5 He is

Looking for a solution...

Answers:

1. The sixth number is counted twice if we add sums of first six and last six, while the sixth number is excluded if we add sums of first five and last five. Therefore, if all the sums are added then all the eleven numbers are counted twice.

Hence average

$$=\frac{(6\times70)+(6\times80)+(5\times80)+(5\times76)}{22}$$

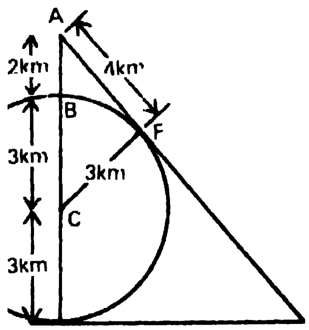
$= 76.36$

2. $\triangle ACF$ and $\triangle AED$ are similar

Therefore, $\frac{l(DE)}{l(CF)}=\frac{l(AD)}{l(AF)}=\frac{8}{4}=2$

Therefore, $l(DE) = 2\,l(CF) = 2\times3$

$= 6$ km



3. Let the original ratio of wine : water be x : y

Therefore, $\frac{x+1}{y-1}=\frac{7}{8}$ and $\frac{x-1}{y+1}=\frac{2}{3}$

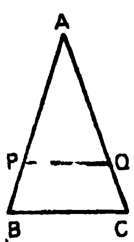
After solving we get $x+y = 30$ gallons.

4. There are five statements. If we read in reverse order the thief can be identified He is convinced C cannot be the thief. Therefore, either A or *his cousin* may be thief. As C is not a thief *D is responsible*. Hence B cannot be responsible As B is not responsible, A cannot be the thief. From this it can be concluded that his cousin and D are responsible for the theft

5. $\triangle APQ$ and $\triangle ABC$ are similar $\triangle$s

Therefore

$\frac{l(AP)}{l(AB)}=\sqrt{\frac{\text{Area of }APQ}{\text{Area of }ABC}}=\sqrt{\frac{1}{2}}$



Therefore,

$\frac{l(AP)}{l(AP)+l(PB)}=\frac{1}{\sqrt{2}}$

Therefore,

$\frac{l(AP)}{l(PB)}=\frac{1}{\sqrt{2}-1}=\sqrt{2}+1$ (dividendo).

6. Let the ratio of unequal arms be x : y and the sugar weighed be W_1 kg when 1 kg is placed in left pan. Therefore, $1\times x=W_1y$, therefore, $W_1=x/y$ Let the sugar weighed be W_2kg when 1 kg is placed in right pan. Therefore, $W_2\times x=1\times y$, therefore, $W_2=y/x$. The total weight $W=W_1+W_2=\frac{x}{y}+\frac{y}{x}=\frac{x^2+y^2}{xy}$

As $x^2+y^2>2xy$, since $x\neq y$, the weight of sugar will be greater than 2 kg

7. The total number of people taking milk is 13 and 2 take only milk Therefore, 11 take milk with tea or coffee or both The sum of numbers of people taking (tea and milk) and (coffee and milk) include the group of people taking all three Therefore, $10+6-11=5$ people take all the three.

8 There are 20 multiples of 5 which when multiplied by an even number would produce at least one zero each Of these 4 multiples are of 25 namely, (25,50,75,100) when multiplied by 4,8,12 (any of 4n type) would produce an additional zero Thus there will be 24 zeroes at the end of the product of first 100 integers.

9 Four men stay in first $2^4=16$ rooms and 5 men stay in first $2^5=32$ rooms that is the fifth man stays in any one room numbered 17th to 32nd Hence the probability that the 27th room is unoccupied will be 15/16

10 Let there be p pigs, s sheep and c cows Therefore, $p+s+c=20$ and $5p+3s+17c=198$. Eliminate p to get $6c-s=49$ As all are integers greater than zero, c cannot be less than 9 Put $c=9$, therefore, $s=5$ and $P=6$ (also c cannot be greater than 9 as $p+s+c=20$).

11 Let the distance AC be 'S' covered in t sec. Therefore AB=2S is covered in 3t sec Therefore, $2(ut+1/2\,at^2)=u(3t)+1/2\,a(3t)^2$, therefore, $at=-(2/7)u$, putting this value in the equation $V=u+3\,at$, we get $u=7V$

12 Let the reduction in speed $=K\sqrt{n}$, therefore, $(24-20)=K\sqrt{4}$, therefore, $K=2$.

Reduction in speed cannot be more than 24 mph

Therefore, $\sqrt{n}$ cannot be greater than 12, therefore, n =143

Time to think hard...

finally convinced that C cannot be a thief. He is able to find the thief. Can you?

5. In a triangle ABC a line is drawn parallel to the side BC such that it divides the area of the triangle into two halves. If P is the point at which it meets AB, then what is the ratio, l(AP)/l(PB)?

6. A baker wants to weigh 2 kg of sugar. His balance is of unequal arms and he tries to weigh sugar with it. He uses the following procedure: (a) Place 1 kg weight on one of the pans (b) Weigh sugar against it (c) Store the sugar Repeat this process once again by placing the weight in the other pan. What will be the total weight of sugar weighed?

7. A group of people take coffee or milk or tea (with at least one person taking all). In this group 10 take both milk and tea, 6 take both milk and coffee and 2 take only milk. If the total number of people taking milk is 13, then what is the number of people who take all three?

8. What is the number of zeros at the end in the product of the first hundred integers (i e., 100!)?

9. A hotel has 1,024 rooms. There are n men staying in the first 2^n rooms, such that not more than one man occupies a room $(1\leq n\leq 10)$ What is the probability that the 27th room is unoccupied?

10. A farmer bought 20 animals consisting of pigs, sheep and cows If the cost of each animal was Rs. 5, Rs. 3 and Rs 17 respectively, how many of each did he buy if he spent Rs. 198 in all?

11. A point is moving with constant acceleration from A to B in a straight line. It has speeds u, v at A and B respectively. If the time taken from A to C (midpoint of AB) is half of the time taken to traverse CB, then what is the relation between u and v?

12. A steam engine without a train can go at 24 mph. Its speed is diminished by a quantity which varies as the square root of the number of wagons attached. If four wagons are attached, its speed is 20 mph. What is the greatest number of wagons with which the engine can move?

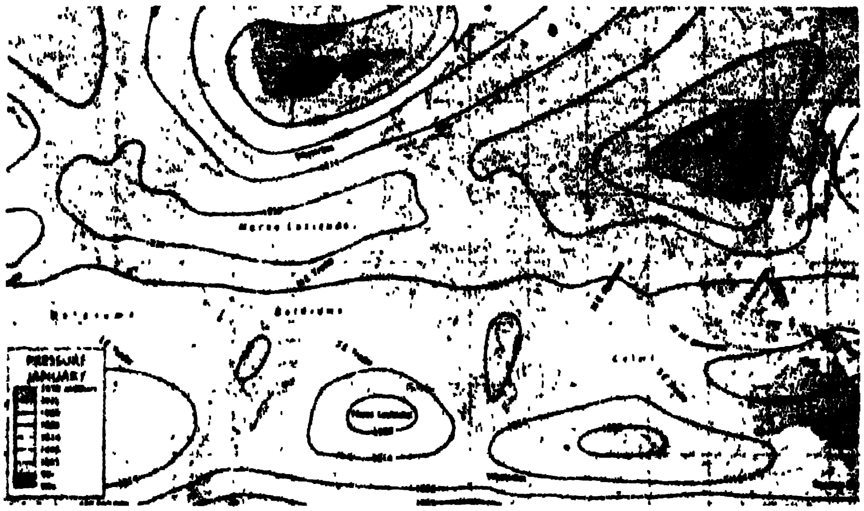
B. A. Naik

Sylvester Lobo

1. Isotropic: B: Equivalence of properties of a material in all directions. An isotropic material will transmit elastic waves at the same velocity independent of direction. Isotropic minerals—those crystallising in the isotropic system—will transmit light at the same velocity in all directions. The condition of isotrophy is contrasted with anisotrophy, in which preferred directions of wave transmission do exist (iso+ Gk. tropos– turn)

2. Isotonic: C: (1) Having the same tonicity. (2) Having the same osmotic pressure on opposite sides of a membrane, said of solutions, especially blood or plasma: distinguished from hypertonic also iso-osmotic, denoting a muscle which contracts against a small but uniform tension or the curve of such a contraction. (3) Music pertaining to, characterised by or having equal tones (Gk. iso - tonous '- having equal accent or tones).

3. Isoclinic: C: Corresponding to equal values of magnetic dip. Isoclinic line (Geophy). A line connecting points on the earth's surface which have the same magnetic dip. Also known as isoclinal (solid state). A line joining points in a plate at which the principal stresses have parallel direction



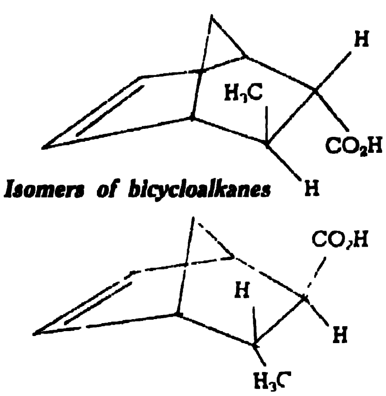
An isobar chart of the world

5. Isobar: B: (1) A line connecting points at equal pressure, such as that which appears on a meteorological chart. The pressures on such a chart are not observed pressures but are corrected for elevation i.e. to sea level. (2) One of two or more nucleides which have the same mass number but which differ in atomic number (Gk. isobars of equal weight as Iso - baros - weight).

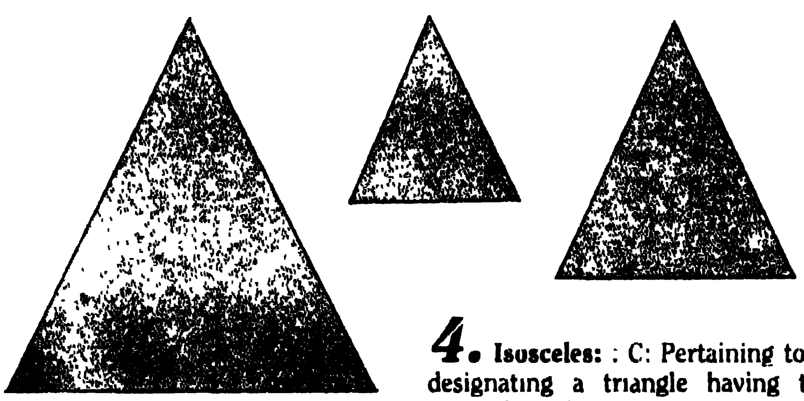
6. Isodose: A: A curve drawn on a chart of an object, connecting points receiving equal doses of radiation (dosis : gift or give).

7. Isochromatic: B: Pertaining to lines connecting points of the same colour. Pertaining to a variation of certain quantities related to light (such as density of the medium through which the colour or wavelength of the light is held constant).

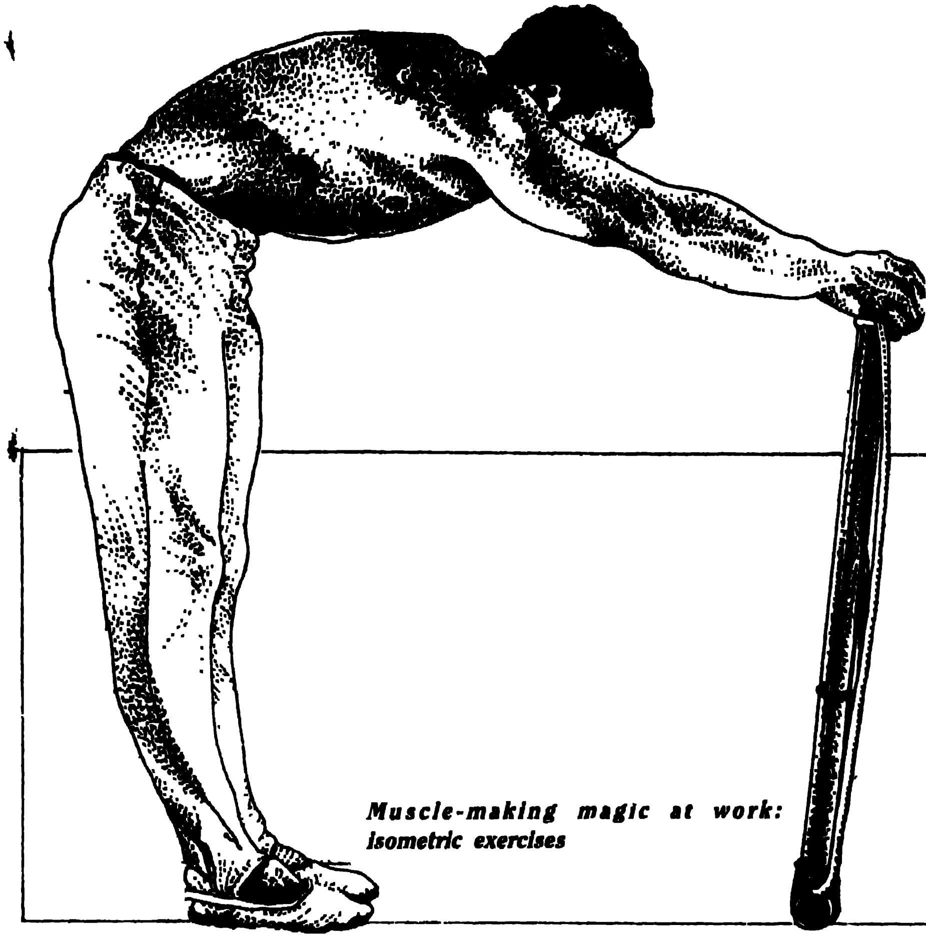
8. Isomers: B: The laws of chemical bonding sometimes permits a given set of atoms to be combined in more than one way, so that two or more substances may exist that have identical chemical composition but different atomic arrangements. Such substances are called isomers and the phenomenon is known as isomerism. The term was derived in 1830 by a Swedish chemist Jous Jacob Berzeliurs, probably from the Greek words isos (same) and meros (part).



Isomers of bicycloalkanes



4. Isosceles: : C: Pertaining to or designating a triangle having two sides of equal length (isoskeles : equal legged ∠ iso. equal + skelos : leg).



Muscle-making magic at work: isometric exercises

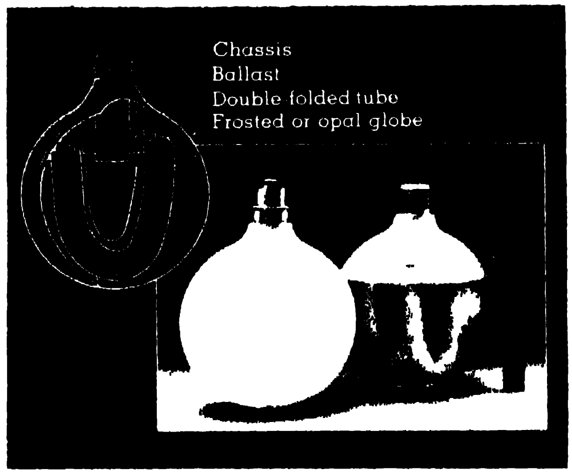
9. Isothermal: B: (1) Having the same temperature (2) Designating a layer of atmosphere lying above the region of convection also called stratospheric (3) of or pertaining to an isotherm. Isothermal processes are those conducted without any temperature change. (Gk. therme - heat).

10. Isometric: B: Of equal measure, without change of shape (drawing) with plane of projection at equal angles to three principal axes of object depicted. (Physiology of muscle action), devoloping tension while muscle is prevented from contracting, isometrics system of physical exercises in which muscles are caused to act against each other or against a fixed object (Gk. isometria as isometry).

Folded fluorescents are coming

THE disadvantage of fluorescent tube-lights is that their straight tubes, external starters and bulky, current-stabilizing ballasts make them suitable only for wall or ceiling fixtures Of late, manufacturers have been putting out slimmer tube-lights having a lower power consumption.

However, even more compact tubes with folded or round shapes, which can be screwed into lamp sockets, like bulbs, are being developed by manufacturers in Europe and Japan. The fluorescent lamps use high-efficiency, rare-earth phosphors (Phosphors are chemicals that absorb radiant light of a given wavelength and re-radiate at longer wavelengths. In conventional tube lights, mercury is vaporized to give off short-wave ultraviolet light which on striking the phosphor-coated tube is converted into visible light). The new phosphors enable more light to be produced from the small diameter tubes than is possible with the less efficient, 'cool' phosphors in the standard larger tubes, electronics has replaced the bulky control gear and reduced power drain.



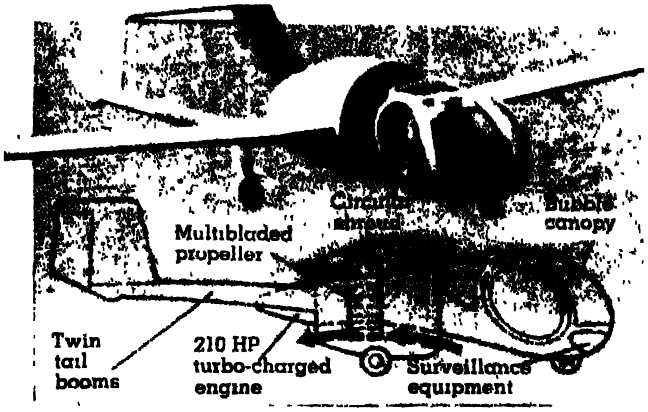
This compact fluorescent has an integral starter and ballast plus a screw base. The tube is double-folded for a longer discharge path. The sealed outer globe has vents at top to keep the inner tube near optimum temperature

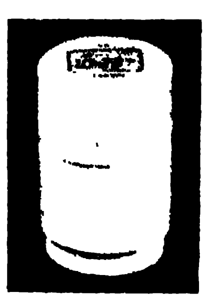
The new compact fluorescents use folded or specially contoured tubes to ensure a long discharge path within the confines of a small space. For peak efficiency, the glass temperature must be around 40°C. To ensure this, cooling zones have been created in some of the models by means of tube joints and bends One model, the Miser Maxi-Light, even dispenses with phosphors, light is produced via an arc discharge struck through metal halide vapours inside a quartz tube. The 55-watt Miser Maxi-Light gives 2250 lumens--about as much as a 150-watt incandescent lamp

Hybrid micro circuits for space applications

HYBRID micro circuits (HMCs) have been developed by the Central Electronics Engineering Institute, Pilani, using thick film technology. A HMC is a small, encapsulated module containing an electronic circuit on a substrate Units have been supplied to the ISRO Satellite Centre, Bangalore for use in SROSS-1, the next Indian satellite to be launched in 1984 85 from Sriharikota

The thick film technology consists in screen-printing conductor and resistor inks on to a flat ceramic substrate to form the basis of an electronic circuit These inks when fired become an integral part of the geometry to give a desired resistance value and tolerance. Further circuit elements, active and passive, may then be added to complete the circuit Semi-conductor chips are mounted directly on the substrate and wire-bonded to the conductor. These semiconductor devices may be simple diodes or LSI chips. Alternatively, miniature packaged components can be soldered or epoxied to the substrate.





Helicopter sans noise

A BRITISH prototype for a high-stealth photo-reconnaissance plane is designed to offer the slow flight of a helicopter without the noise. It can't quite hover, but it can fly at 80 kmph and operate from short strips Called the Optica, its wasp-like waist enables air to be drawn into a large, shrouded pusher-propeller.

Medicine bottle that remembers

AN American engineer, Bart Zoltan, has invented a medicine bottle that records the date and time when it was opened last. Quite handy for those patients who are forgetful or too ill to remember. CAP, as it is called, is expected to be on the market this year

Oscilloscope with automatic time range

OSCILLOSCOPES are universal measuring devices which have become indispensable in both analog and digital applications. A dual-channel oscilloscope with new automatic time range feature is the latest addition to the family. It has a front panel with colour coded sections permitting swift, error-free operation so that even inexperienced users can handle it efficiently.

The oscilloscope contains an automatically focussing picture tube producing clear sharp images, by means of which the measuring signals are displayed on an 8 × 10 cm screen. The screen surface is sufficiently large and bright for the finest details to be recognised even with the highest resolution. In both channels the user can produce "static images" as both signals can be triggered independently of each other.

In addition to the standard time base, a second delayed time base is available with which any non-expanded part of a signal can also be displayed in an expanded form. This second time base can be triggered separately and produces a static image even with non-correlating signal components.

The new oscilloscope is suitable for use in all measuring and test stations in research and development and also in commissioning, service and repair of all kinds of electronic equipment. It is a compact unit, and includes electric protection against operating errors. Its low weight of 9.6 kg makes it easy to carry it to different locations.

The dual-channel oscilloscope, incorporating a new automatic time-range feature with which measuring signals can be represented with a resolution from 1.5 to 5 periods

Parboiled rice sans odour

THE new pressure parboiling technique of preparing parboiled rice *(sela)* offered by the Central Food Technological Research Institute (CFTRI), Mysore, saves time and cost, and has higher turnover than existing techniques. It also does away with the bad odour associated with parboiled rice.

The method consists in merely wetting the paddy, followed by steaming at a pressure of about 1.08 kg/sq cm. The resulting parboiled rice is gelatinized only partially and has a small 'white belly' in the centre, which is needed for reasonably quick cooking and for reducing discoloration. Complete gelatinization must be avoided in pressure parboiling.

The process is a modification of the technique originally developed by the Paddy Processing Research Centre, Tiruvarur (Tamil Nadu), which involved soaking the paddy for about 30 minutes in cold water and then steaming at 2.16 kg/sq cm for 15 to 30 minutes.

Both the hot-soak and the pressure parboiling methods have overcome the bad odour of parboiled rice produced by the traditional method which involved soaking 20 to 50 tonnes of paddy in water in underground cement tanks either at room temperature or around 40°C for three to four days or 1.5 days, respectively, followed by open steaming in 150 to 700 kg lots for three to eight minutes each.

Khoa-making equipment

AN easy-to-operate, fuel-efficient equipment to ensure *khoa* of uniform quality has been developed by the Engineering Division of the National Dairy Research Institute, Mangalore.

Khoa is an important ingredient of Indian sweets, prepared by evaporating water from milk until the total solids have increased from 70 to 75 per cent in small, shallow, round-bottomed iron pans placed over a brick fire, the milk is stirred constantly until it becomes viscous.

The equipment consists of a stationary, mild steel jacketted drum with inside rotating blades and a foam column at the top of the drum to accumulate the raised foam during boiling. The blade is in contact with the inside surface of the drum and is rotated manually. One kilogram of milk can be converted into *khoa* in 7.5 minutes.

Recording rainfall at remote sites

EVEN an instrument so essentially simple as the rain gauge has been transformed by the application of microelectronics. The Digital Recording Rain Gauge announced by a British firm allows water-supply authorities, river and drainage boards and national weather services to record rainfall accurately at remote sites where frequent visits are impossible.

One version of the instrument has a built-in electronic memory which can record the total daily rainfall each day for more than three months. Another version can record the exact times of day at which rain fell, again over a period of several months. Alternatively, the pulses produced by the instrument are suitable for automatic transmission by radio or telephone link to the headquarters of water-control authorities, giving them immediate information about heavy rainfall and providing advance warning of flood danger.

The upper, funnel section of the gauge (shown removed in the photograph) collects rain falling through an aperture of precisely 400 cm², and channels it via flow-moderating device to a 'tipping-bucket' mechanism below. Rain flows into the upper half of the divided bucket until, when this is full, the mechanism tilts like a see-saw, discharging the collected water and allowing the other half to begin filling. The alternate filling and discharging continue so long as rain is falling, and at each tilt a magnet closes the contacts of a reed-switch, which emits a pulse. Each pulse can represent 0.2 mm or 0.5 mm of rainfall.

This electronic rain-gauge can operate for more than three months unattended

The base of the gauge can contain a battery-powered and weatherproof electronic memory. This counts the pulses for each day, and every 24 hours records the total and starts a new count. When the gauge is eventually visited, the daily totals are displayed in turn on a digital liquid-crystal counter, which is then zeroed for re-use.

Alternatively, the firm offers a weatherproof on-site data logger. This records the time of every pulse in a removable solid state memory module. Every few months the module is exchanged and the recorded information can be printed out by computer.

Viewpoints

➔ *from page 29*

tried out as a part of preventive measures for certain psychological afflictions. Unfortunately, girls play less than boys in all classes of society as they have to bear the additional responsibilities of either working or looking after the younger members of the family. These are also the reasons why they discontinue their education and drop out from schools at an early age.

Significantly, the Democratic People's Republic of Korea accords the highest priority to health care and well-being of its most precious possession, the children. At all levels the attempts are to see that the children grow well and regularly in total harmony with the environment.

We have a long way to go in providing health for all our children. All the investments in child health ultimately leads to improved social development, productivity and better quality of life. Improved education, health and social status of women in general is an issue fundamental to the health of children and society.

Closely interrelated to this issue is the concept of equality for all. A basic level of health care is the right of all people and not only of the privileged few or for the urban population. The recent emphasis on high technology and big hospital set ups in contrast to near or complete absence of primary health care system in several of our villages and remote places, and even in our cities, is proving to be catastrophic. Let's face it now at least, the high tech. western model which we have adopted is not for us. We must build a strong primary health care system to suit our own needs with greater emphasis on preventive and educative measures.

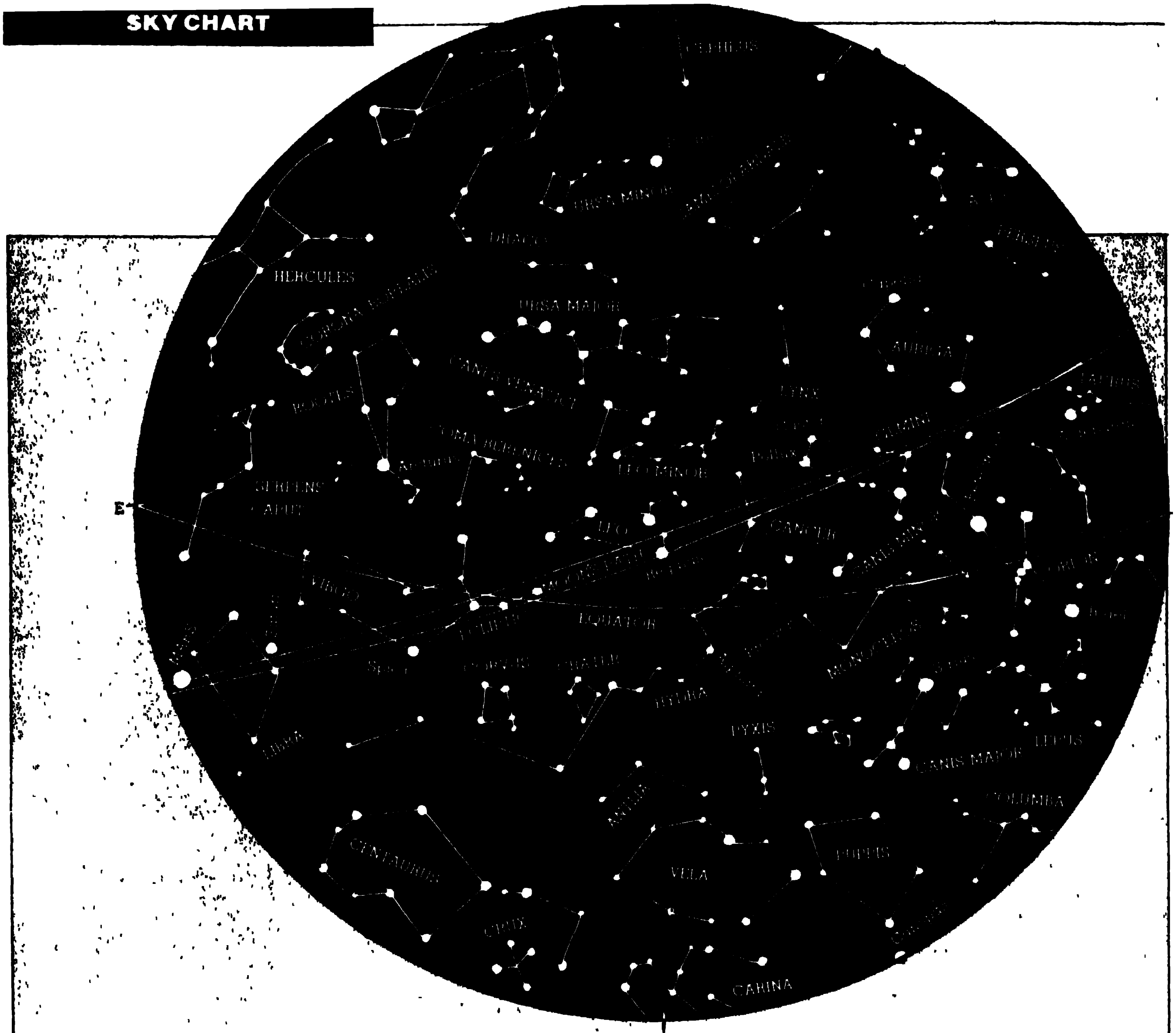
In conclusion, a child's health is its legitimate right. These are the rights which the UN formally recognised in 1959 and which have been ratified by all UN members. The journey is long and arduous. But there's no way out, for our future depends on it. □

Simin Irani

Dr. Irani is professor of Pediatrics (Neonatology) at the G.S. Medical College and the K.E.M. Hospital, Parel, Bombay. She is closely involved in several [illegible] and [illegible] projects on neonatology and perinatology and is a founder member of the Neonatology Forum of India.


Stop bad breath...
Fight tooth decay
Colgate
DENTAL CREAM
Colgate
STOPS BA
Colgate's
trusted formula works
to give you clean,
fresh breath...
strong, healthy teeth
every time you brush.
Here's how:
Odour- and decay-causing bacteria grow in food particles trapped between your teeth
Colgate's unique active foam reaches deep to remove dangerous food particles and bacteria
Result Fresh breath confidence, protection against decay, strong healthy teeth
Remember to brush with Colgate Dental Cream after every meal· Stop bad breath fight tooth decay
You'll love its fresh minty taste!

SKY CHART



SKY IN APRIL

Mars becomes retrograde

Nagpur 21.00 H (IST) 15.4.1984
Latitude = 21°9' N Longitude = 79°6' E
Sidereal Time = 10h. 22m. 18.6s.

THE Earth is now gradually approaching Mars. In their respective orbits, they are now moving side by side. Since the speed of the Earth is (always) faster than that of Mars, and the orbit of Mars lies beyond that of the Earth, Mars would now appear trailing backward (westward) in the sky. This retrogade motion of Mars occurs once every two years. At the beginning of the current year, Mars was seen slightly north of the star Spica in Virgo. Since then it has been advancing forward (eastward), and becoming ever brighter. On 31 March, it was seen between Libra and Scorpius, shining as the most bright object around. Its forward motion is now coming to a halt. On 5 April, it will become retrograde and begin to step back towards Spica. This will continue till 20 June, whenceafter it resumes its forward motion for another two years

Saturn, now in its brightest phase (looks as bright as Rigel in Orion) and to be seen in Libra somewhere between Mars and Spica, is also in retrograde. Jupiter will also become retrograde by the end of the month. In fact, if you see a planet rising in the east just before or after the local sunset, you must be sure that the planet is in retrograde motion, very bright in appearance, and bigger in size than usual. This should be the most favourable time for observing them, as they spend the whole night with the observer.

Like the outer planets, the inner ones, Mercury and Venus, also become retrograde when they come closest to the Earth. Mercury is now present in the evening sky, only a few degrees to the left of Aries, and can easily be spotted with the naked eye during the first week of April. It will then become retrograde on 12 April, and leave the evening sky because of its westward motion. It will soon overtake the Sun on 22 April and come closest to the Earth on April 25. It reappears in the morning dusk after the first week of May

N. C. Rana

... why people DROWN

SOME objects float in water while others sink Whether a body including the human body—will float or sink depends on its specific gravity Specific gravity is the ratio of the density of the body to that of water. The specific gravity of human body is found to vary between 0.9 and 1.05. In fresh water, a person has to have a specific gravity less than 0.9875 to be able to float. When we inhale and fill our lungs with air the specific gravity of the body decreases and it increases when we exhale

In a study of hundred males, G. Highmore *et al* found that only 16 per cent were constitutionally non floaters and would sink even with their lungs full of air Among boys only 7 such sinkers were present in a sample of 1040. The ability to float was found to be maximum in the range of 10 to 13 years

Why is drowning so commonplace if the majority of people can float? The reason is simple, people panic and start breathing frantically and swallow water along with air Once the lungs are partially filled with water, two things can happen First, the specific gravity of the body may increase sufficiently to make the person sink Second, even if the person manages to float the capacity of the alveoli in the lungs to exchange carbon dioxide for air could be drastically reduced resulting in suffocation All this can happen so quickly that on an average it takes only 40 seconds for a person to drown

Another hazard, fortunately not prevalent in our seas is the danger of hypothermia, when the body gets cold. Body heat is lost *twenty* times faster in water than in air of the same temperature. The heat loss is mostly from the sides of the chest, the head and neck, and the groin where the legs join the trunk. As the body gets colder, the blood vessels to the extremities constrict to prevent further loss of heat and to keep the vital organs like the heart, brain and the lungs warm. The skin, muscles and gut can survive for over an hour without blood circulation but the brain will get damaged irreversibly just after four minutes Once the body temperature goes down to 29 4 to 32 2 degrees centigrade (the normal temperature is 37.2 degrees centigrade), it can lose its ability to warm itself without external help Below 29.4 degrees centigrade the heart stops beating, but prior to this the person loses judgement and coordination and will inhale water. And the cause of death will be wrongly attributed to drowning.

Wrong methods of first aid may actually kill the hypothermia victim rather than revive him. Vigorous rubbing of the limbs or the application of hot water bottles will lead to what is known as *afterdrop*-the cooler blood from the extremities is pumped back through the heart decreasing only briefly the temperature of the heart, but causing heart failure. This happens if the temperature falls below 30 degrees centigrade. Making the victim breathe warm air (40 degrees centigrade) saturated with water vapour to raise the body temperature is a good method of reviving The next best method is to put him in a hot bath (42 2 degrees centigrade), although here too lies the risk of an afterdrop.

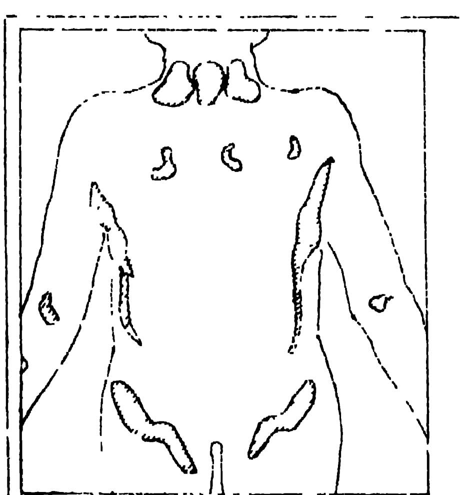
Swimming in cold water can lead to rapid cooling of the body, due to the increased flow of body heat into the surroundings Then the best way for a swimmer to conserve body heat is to resort to HELP—Heat-Escape-Lessening-Posture, holding the arms tightly against the chest, with the thighs raised and pressed together and the legs crossed.

The body in this position will not be stable, however. The body weight acts downward through the centre of gravity and the upward thrust of the water is through the centre of buoyancy.

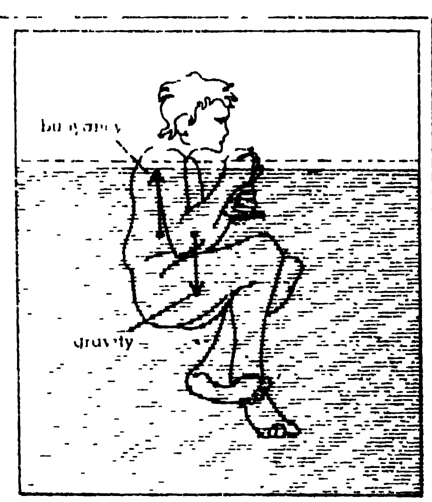
Since these two forces do not act along a line the body tends to rotate in the forward direction The new position of equilibrium has the head down and the legs up. A life jacket will avoid this awkward situation and will help keep the body erect

Finally, we are asked not to swim after a meal. This is because blood is diverted to the stomach after the meal, to aid digestion. If the heart is weak or the swimming too vigorous, blood supply to the stomach gets shut down since more oxygen is demanded by the exercising muscles Since the stomach must contract when it has food in it, it will continue to contract until its muscles run out of oxygen, and the person will suffer abdominal cramps and drown.

Shaded regions are the parts of the body that lose heat readily in cold water



Heat-Escape-Lessening-Posture (HELP) to conserve body heat



B. F. Chhapgar

Dr. B F Chhapgar is Scientific Officer for Aquatic Radioactivity Studies at the Bhabha Atomic Research Centre, Bombay.

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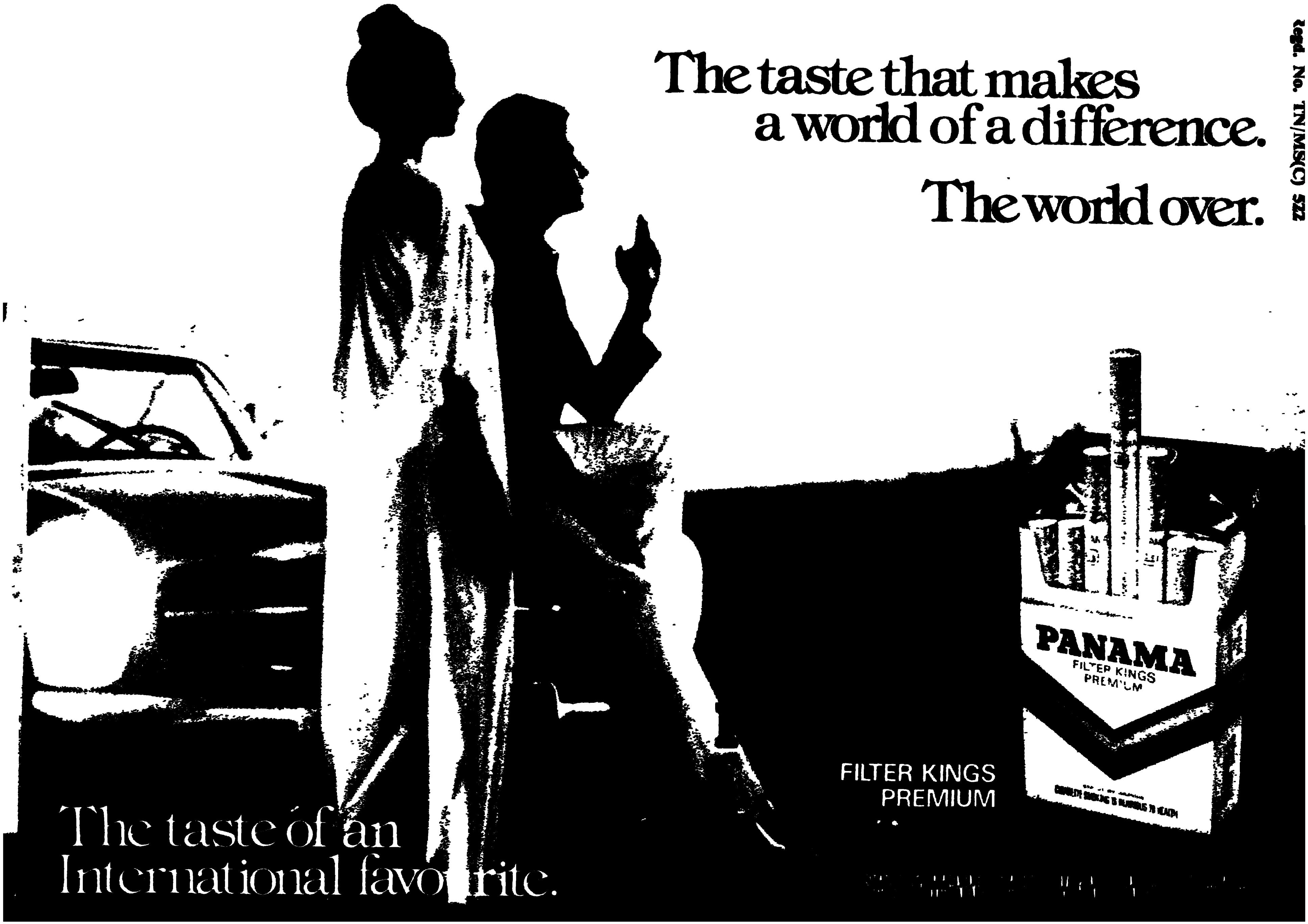

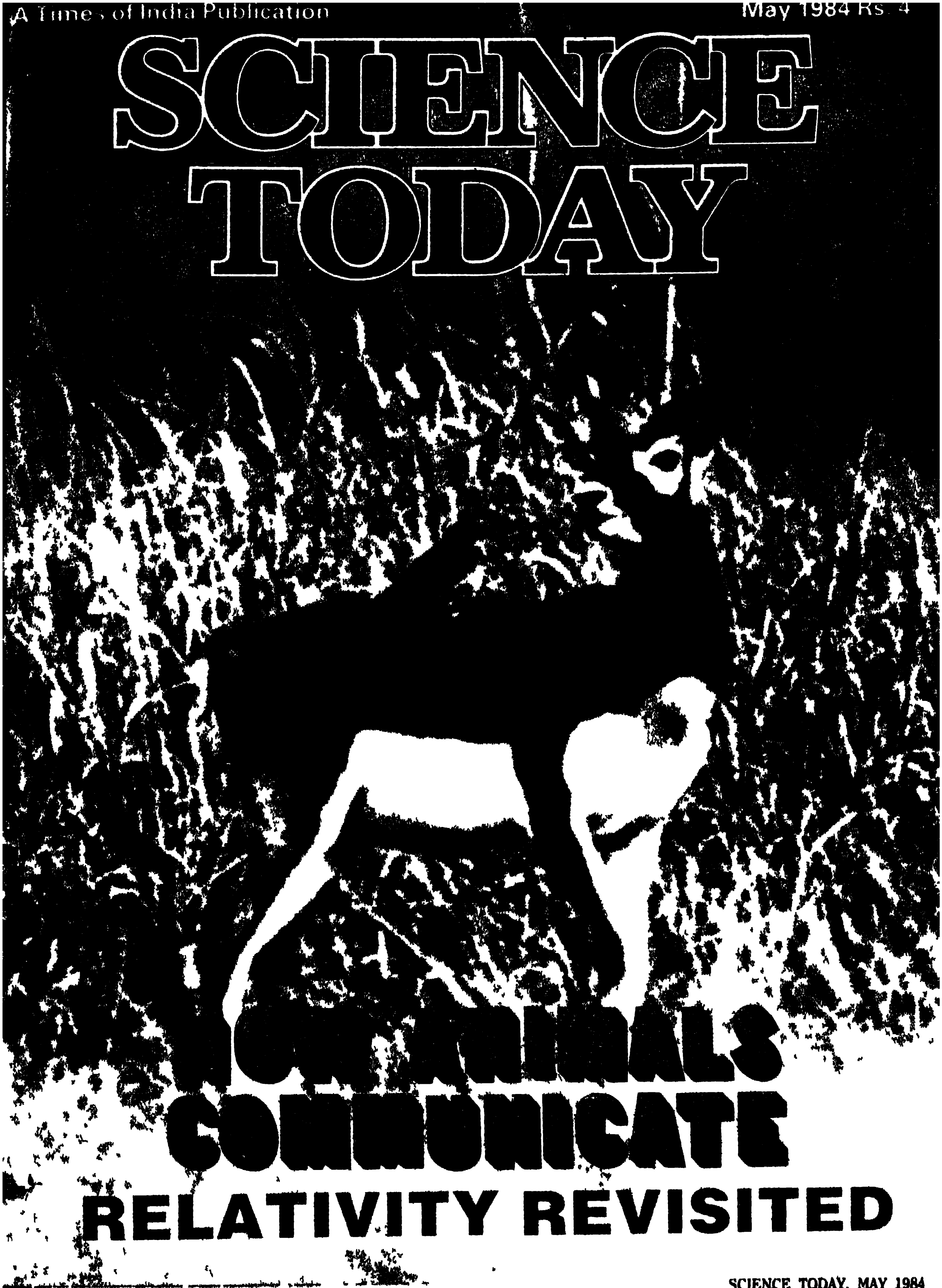
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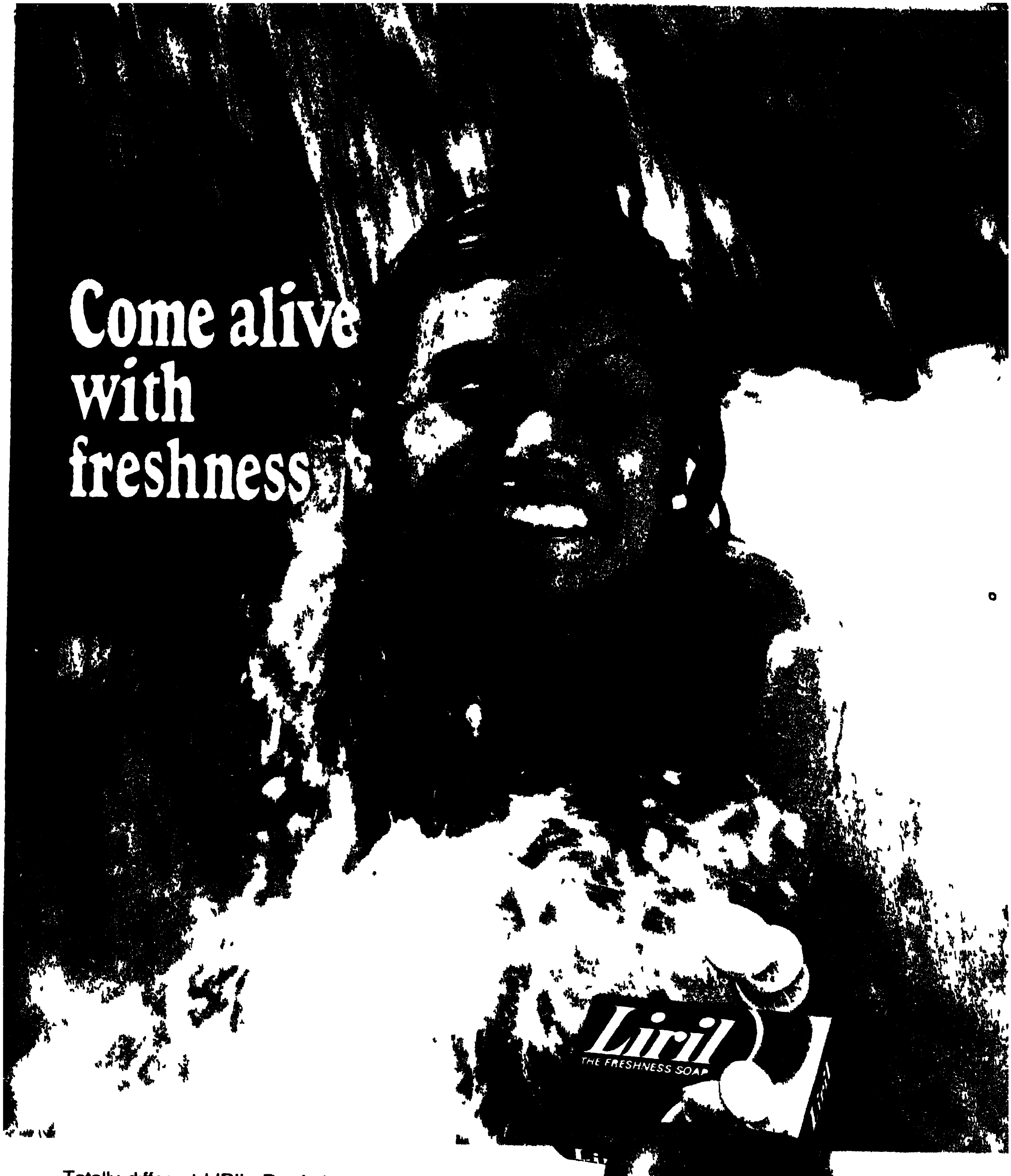

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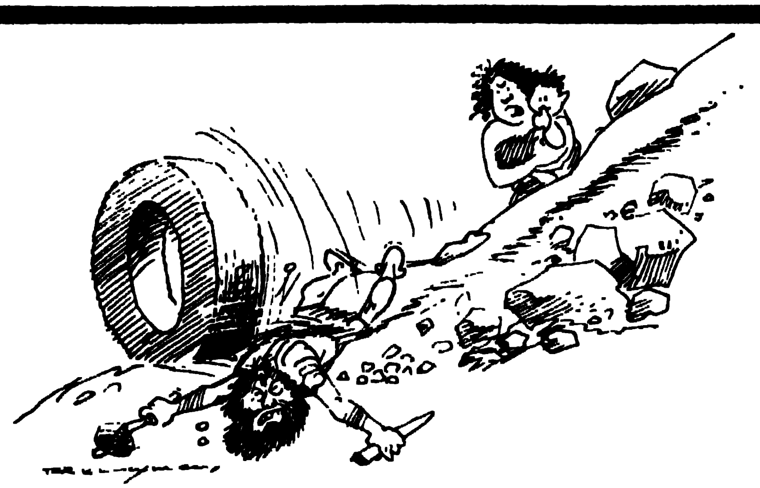
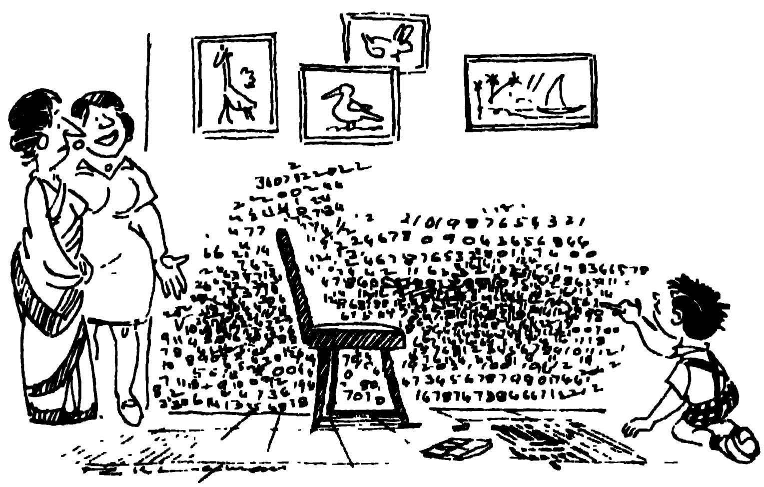


I told you to give up the crazy idea to invent that thing...

I got the idea from a jet plane.

R. K. Laxman

He is cured, Doctor. But I'm worried about his expression of utter wonder which he has been having since he took that wonder drug!



Since he swallowed some micro-chips he has been busy doing nothing but this.

SCIENCE TODAY

Vol. 18 No. 5 May 1984

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THE eighteenth of this month will mark the tenth anniversary of the Peaceful Nuclear Experiment (PNE) conducted at Pokhran. The two main architects of that experiment are now at the helm of affairs at the Department of Atomic Energy (DAE). It would be appropriate, therefore, to assess the impact of PNE on our entire atomic energy programme.

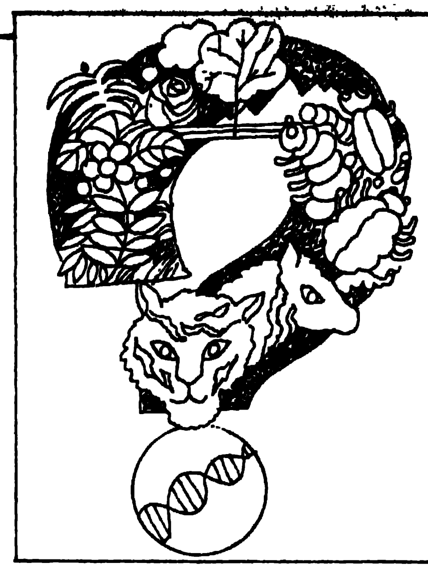
There is no denying that, prima facie, PNE, instead of giving a shot in the arm to our programme of nuclear power development has caused a setback. Canada who was our collaborator openly protested and withdrew its helping hand. The US started dragging its feet on the supply of enriched fuel for the Tarapur Atomic Power Station in spite of a prior commitment which is to last till 1993. Although the excuse given was India's refusal to sign the Nuclear Non-proliferation Treaty as well as to permit total inspection of our nuclear facilities, the nexus between these and the PNE in the minds of policy makers in Washington was quite evident. There were—and continue to be—additional indirect pressures and hurdles. Any supply of material to the DAE from a US-based firm now needs explicit clearance from the Export Clearance Committee. And there have been instances when such clearances were not forthcoming even for materials that can be used only for biological or medical research and can have no application whatsoever in defence technology. The International Atomic Energy Agency (IAEA) is also being manipulated to force India into giving up her options. The recent suggestion that India should vacate her seat on the board of the IAEA is also a step in the same direction. However, before concluding that the PNE was an ill-advised venture one should take cognisance of certain recent developments that, we feel, have a direct bearing on this matter.

A large number of reports are circulating of late—and with increasing frequency—that Pakistan has developed what in the popular press jargon is called the Islamic Bomb. Although this specific development could be disputed, these reports firmly indicate that our neighbour has acquired the capability for enrichment of uranium. Pakistan does not have any power reactor which uses enriched fuel; nor does it have any such future programme. It is difficult to accept, therefore, that this enrichment capability will be exploited for peaceful purposes. Despite this that country is not being subjected to the same pressures as were brought to bear on us over the last decade. Even the Dutch enquiry into allegations that the centrifuge technology acquired by Pakistan was "stolen" from the Netherlands has given an ambivalent report.

It is abundantly clear, thus, that PNE is merely being used as a convenient flogging horse and all the different polemics are mere devices the nuclear "have's" use to maintain their control over the "have-nots". These efforts would not have diminished even if PNE was not conducted. Nuclear technology has come to stay and is going to play a significant role in future too. Acquisition and mastery of this technology in all its facets has to be our objective even without the political and strategic imperatives.

Let the tenth anniversary of PNE, therefore, be celebrated neither with euphoria nor with despondency but with a dispassionate yet resolute commitment to continued self-reliance in nuclear technology.

EDITOR



INTEGRATED BIOLOGY

This is with reference to the viewpoints on 'Integrated Biology', by Rev. Lancy Pereira (February,1984).

I am not one of those teaching in any of the 'best university departments' nor am I (as a consequence?) perhaps one of the 'better minds' as correlated by Rev. Pereira. This may be the reason why my mind works in a direction contrary to what the author has written in support of 'Integrated Biology' and the experiment that is in progress at the Bombay University. Rev. Pereira has analysed all aspects of the possible criticisms that are likely to be advanced against an integrated course in biology. His introduction to the writeup is superb and well illustrated to show how the world is at present to be viewed as a single 'organism' floating in the immensity of space (and there could be many more such 'organisms' at various levels of 'organisation' distributed widely throughout the universe).

While it may be true that biology is heading towards a kind of integrated holistic approach, we must not forget that this is not altogether a novel approach. This is exactly the way early naturalists, such as the ancient Greek philosophers, viewed nature and tried to understand it. What is happening today is simply a return to the ancient way of learning, though with greater insights as to what a living system is. If, in the 3rd century BC, only a handful of philosophers could contemplate holistically about life on the Earth, today, a similar understanding of the living world is expected from scores of students who pass out from our universities that offer an integrated approach to biology. But the question is, do they really acquire such a broad understanding of the living world?

Study of an organism starts with a study of its parts. It is only after mastering the aspects of all its parts that one understands the whole organism in the right perspective. When one teaches plant science, for instance, one has to begin with the parts of a seed plant. Only later the student is gradually introduced to different types of plants, etc. Similarly, a detailed study of biology under separate headings such as Botany, Zoology and Microbiology has its own advantages as the students come to understand the diversity of life on this planet. Rev. Pereira has rightly said [to quote] "....I am not saying that a more specialised study of animals or plants or microbes as separate disciplines is not good or useful biology.. ".

While it is true that at certain levels of learning an integrated approach may become necessary, it need not replace a detailed study of plants, animals and microbes. While some of the centres of learning in the country could experiment with integrated biology courses (as is being done at the Bombay University), other centres could and should continue somewhat in the traditional style, teaching biology under separate disciplines of Botany, Zoology and Microbiology, though there still could be more interaction between these disciplines in certain borderline areas.

Regarding high scoring in competitive exams by students of integrated biology courses, perhaps in such exams the questions are set by persons who are biased towards such an integrated approach to biology. It may be a good experiment to offer in such competitive exams two question papers [or two sections of questions in the same paper]—one in integrated biology and another in traditional biology (Botany, Zoology or Microbiology) and see the performance of each student. Even the courses offered in biology departments at the various centres of learning could be in two streams: one with an integrated holistic approach and the other with a traditional emphasis.

D. E. P. JEYASINGH

Madras Christian College,
Madras 600059

I disagree with the views of Lancy Pereira (February 1984) on introduction of an Integrated Biology at university level. He is not aware of the Central Board of Secondary Education syllabus. The so called "Integrated Biology" is already being taught to the students of standards X, XI and XII in sufficient detail. Every sub-biological branch—evolution, molecular biophysics, bio-chemistry, biology, genetics, etc is dealt with, in this course. The only difference is that the course is spread over three years.

I feel that the Universities are right in offering specialisations in particular sub-biological fields, when there is so much burgeoning knowledge, with more being added continuously.

SHIV NATH

Rajinder Nagar,
Dehradun,
U P 248 001

Oh! Those printer's devils

An error has crept in on page 65, para 1, line 7 of my article 'Daylight robbers' (March 1984). It should read "with a little expertise, *the bins* may be sprayed with an insecticide", and not the grains, as mentioned in the article.

A. J. TAMHANKAR.

Entomology Section
Biology & Agriculture Division
BARC, Bombay

In scientifically speaking (March 1984), the answer for 'dressing' is not appropriate. By definition, 'The process of removal of gangue, that is, unwanted impurities from the ore is technically termed as ore-dressing or concentration of ore and not as turning ores into pure metal.'

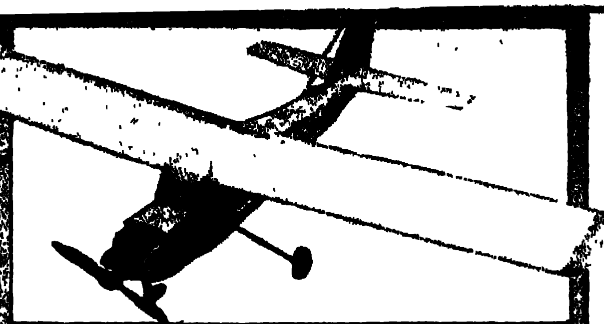
S. VIJAYARAGHAVAN

Coimbatore
Kerala

In our article on Marine Minerals (March 1984) an error has crept in our reporting two figures. On page 57, column 3, under *Chemicals and metals from sea water* the figures 222 and 530 should read as 356 and 1352 respectively.

R. A. NAGLE

Uranium Extraction Division,
BARC Bombay



[illegible]

I am a student and interested in building a model of an aeroplane at home. From where could I get proper guidance?

K. [illegible]

[illegible]

The [illegible] article has stimulated me and my friends to build models in our school laboratory. We need addresses of the manufacturers.

S. C. [illegible]

[illegible]

For [illegible] contact:
Mr. C. R. [illegible]
[illegible] Trading Company,
[illegible] St. [illegible]
[illegible] Road, Mulund (West),
Bombay-400 080.
[illegible] Model Mfg. Co. Pvt. Ltd.
[illegible] Street,
Calcutta 700 071
For model engines contact:
Mr. Mahesh Kumar Sharma,
Sharma Model Aero Engines & Propellors,
[illegible] Bldg., Ratanda Road,
Jodhpur 342 001.

Titanium—the metal with a future

The article 'The metal with a future – Titanium' (January 1984) by Dr R M Sathe deserves congratulations The last sentence of the article, 'And in case our resources get exhausted we can always import it from the moon', probably reflects author's deep anxiety about the future availability of titanium-bearing raw materials.

In the text. Dr. Sathe has rightly mentioned ilmenite and rutile as the two most important minerals of titanium which are available in Kerala, Tamil Nadu, and Orissa, especially the ilmenites.

It is pertinent to mention that India has vast deposits of bauxites (aluminium-bearing ores used in the production of aluminium metal) and Indian bauxites are characteristically high in titania (TiO_2) content. With the current estimated reserves of Indian bauxites placed at more than 1,350 million tonnes, the contained titania may correspond to nearly 135 million tonnes, that is, more than the titania contained in the combined reserves of ilmenite and rutile

Finely ground bauxite ore is treated with caustic soda to dissolve alumina, leaving a solid residue called 'bauxite residue' or red mud' typically containing Fe_2O_3 35%, Al_2O_3 23%, TiO_2 17% and SiO_2 5%, besides minute quantities of vanadium and gallium For every tonne of processed bauxite 0 3 to 0 4 tonnes of red mud are produced Over the years, we have accumulated millions of tonnes of red mud. Huge quantities of red mud will be generated by the giant MALCO plant, at Coimbatore, when it goes on stream This material is a waste product and is presently left behind in ponds occupying large land areas This causes serious environmental pollution problems, besides the loss of metal values contained in it

Red mud is a potential source of titanium, especially because the original bauxite has undergone costly physical and chemical treatments and the extremely fine powdery material is ideal for further physico-chemical operations to recover titanium. Development of such a technology is a challenging task but well within the realms of a possibility. Add to this minute quantities of rare and strategic metals like vanadium and gallium, which also can be recovered simultaneously as a bonus to give an overall economic benefit in the extraction of the all-important titanium from Indian bauxites.

Recovery of titanium (along with other important constituents of red mud) thus will not only enormously enhance the quantitative potential of the metal with a future' but will conserve the mineral wealth of the country on one hand and solve the environmental pollution problem caused by the indiscriminate disposal of red mud For many many years to come we may not have to make a trip to the Moon, at least for titanium

B. R. SANT

CSIR [illegible]
Hyderabad

I read with interest the article Titanium-the metal with a future", (January 1984) Titanium as pointed out, has diverse applications I wish to point out a new application of a titanium alloy in the field of orthodontics to perform tooth movements. Titanium at temperatures above 1,625°F rearranges into a body centred cubic lattice, called the beta phase The beta structure can be maintained at room temperature by the addition of elements like molybdenum or columbium. Such alloys called the beta stabilised titaniums have unique properties.

A composition alloy of 11% molybdenum, 6% zirconium and 4% tin with beta titanium in the form of a wire has the following physical properties: Modulus of elasticity = 9,400,00 psi yield strength -170,000 psi, YS/E ratio - 1 8x 10 (stainless steel - 1 1 x 10)

This wire has been found to have near ideal properties in performing tooth movements The wire has excellent formability, high spring back and is weldable These fulfil most of the criteria of wires for use in orthodontic appliances For a comparable section of steel wire, the beta titanium wire delivers four times greater force Nitinol wires,though they compare well,lack formability

Both beta titanium and nitinol wires are expensive Orthodontists import the wire for use, and Indian customs levy 320% duty thus taking the costs to still higher values This takes it out of reach of the average practitioner since four to six units of wire are required per patient India having vast resources of titanium, should shed its lethargy and become a leading manufacturer of titanium sponge, and stabilised titaniums This product has great potential both at home and abroad

K. JYOTHINDRA KUMAR

Department of Orthodontics,
Medical College Trivandrum
Kerala.

Will Halley's comet disappoint viewers?

WILL the return of Halley's comet in 1985-86 be a most spectacular astronomical event? It appears we are in for a disappointment What will the comet look like? Surveying the situation, Ian Halliday of the Herzberg Institute of Astrophysics in Ottawa, Canada, says the comet will not look good *(The Journal of the Royal Astronomical Society of Canada)*

The appearance of the comet in 1910 was so spectacular that, photographed by the largest telescopes of the time, it became a kind of astronomical allegory Soon after the comet s closest approach to the Sun, it had a bright coma (the gaseous and dusty clouds that envelop the nucleus of a comet) and a luminous double tail extending across a fourth of the sky (SCIENCE TODAY, September 1983, p 15) According to Halliday, however, the geometry of the comet's orbit on it s 1985-86 passage will be the least favourable of its 29 previously recorded passages Halley s comet follows an elongated elliptical orbit inclined at an angle of 18 degrees to the plane of the ecliptic (the principal plane of the orbits of the planet) A comet is at its brightest and displays its fullest range of activity near the perihelion (the point in its orbit where it is closest to the Sun) When Halley s comet reaches perihelion on February 9, 1986, the Earth will be on the opposite side of the Sun from it indeed the comet the Sun and the Earth will be nearly aligned From the Earth the comet will appear less than five degrees north of the Sun and some distance to the west As a result it will rise less than an hour before the Sun in a region of bright twilight

The comet will come closest to the Earth on 27 November 1985 soon after it passes above the plane of the ecliptic on its way toward the Sun, and on 11 April 1986 about a month after it passes below the plane of the ecliptic on its way out of the inner solar system In neither case will it be particularly close to the Earth and in both cases it will be more than one astronomical unit (the distance from the Earth to the Sun) from the Sun At these solar distances, the comet is not likely to give rise to the expected spectacular celestial display However since the Halley's comet is the only short-period comet that reliably displays a full range of cometary activity and that has a well worked-out orbit, it is possible for scientists to plan scientific missions in advance, this is more than a compensation for the disappointing, less glorious, appearance of the comet

—C. Uberoi

Gosh is neither a sheep nor a goat

HEY! What sort of an animal is this 'gosh'? Take a close look at the photograph below If you think its a goat then you are wrong And, nor is it a sheep

British scientists have manipulated the cells of embryos and produced these sheep-goat chimeras The animals combine the characters of both sheep and goats (For details please see page 18)

Not many animals survived nor all the survivors produced by the embryo manipulation technique, had chimeric characters But the technique has for the first time produced viable offspring between two different mammalian species, sheep *(Ovis aries)* and goat *(Capra hircus)* Rat chimeras *(Mus musculus-Mus caroli)* only had been produced formerly

Sheep-goat chimera

The technique opens up exciting vistas of producing offspring between very different animal species Even the endangered species might be helped by creating suitable conditions for the embryos The latter can be reared safely in a host mother of another type

Prof. Abdus Salam

Third World Academy

A 'Third World Academy' has been launched at last. Prof Abdus Salam, the Pakistani Nobel-laureate and a physicist, is its first president Prof Salam is known for his concern for the directions of the Third World science and a champion of the Third World scientists "The Academy' says Salam, "will be happy to advise governments and other bodies" on matters concerning science, development and technology

To begin with, the Academy has 25 full fellows (two Nobel prize-winners) who are existing members of the prestigious academies and 14 associate fellows The latter are from developing countries but working in the West The functions of the Academy will be to support "good men" in developing countries, to publish a scientific newsletter about third world science and to promote scientific "South-South' collaboration

Unisexual lizards

YOU may not believe it but some of the communities of whiptail lizards (genus *Cnemidophorus*) in the south western US and northern Mexico consist of entirely females This is an example of unisexual lizards which produce their young without fertilising their eggs A hint of their possible existence was first given by a Russian zoologist Ilya Darevsky, in 1958 This has now been experimentally proved reports Charles Cole, the curator in the department of herpetology at the American Museum of Natural history, New York, USA

The experiment was carried out in the lab by raising the first generation females in the absence of males These were then watched until they reached sexual maturity and produced a second generation in the continued absence of

Continued on page 14

Soyuz T-11 spaceship as seen from Salyut-7 seconds before docking

Let's salute the Salyut

BY the time this comes out in print, Squadron Leader Rakesh Sharma with his co-spacemen, Yuri Malyshev and Gennady Strekalov, would be back with us with a wealth of information. Indian and Russian scientists will be busy analysing and interpreting the data/photographs collected in the course of the first Indo-Soviet space flight which lasted for eight days. Perhaps, the full impact of this space research will be known only after months (if not years), when the hundreds and thousands of photographs and charts have been analysed. Remarkably, five minutes of space probes or remote sensing of the Earth with multispectral special cameras do as much work as two years of aerial photography by 50 aircrafts and 80 years of prospecting by geologists. This is just one instance of the manifold powers of space research and our scientists are definetely going to be busy decoding the results of our maiden, manned space venture.

On 3 April 1984, the transport spacecraft of the Soyuz-T series, Soyuz-T-11, launched the international crew of cosmonauts into the near-Earth orbit. On 5 April, it successfully docked with the orbital station Salyut-7, where a rigorous schedule of studies were carried out by the cosmonauts. The Salyut-7 was launched on 19 April, 1982, and since then it has served as a docking and an experimental station. It has hosted two long-duration expeditions lasting 211 (the longest in space) and 150 days and two visiting expeditions. Decades of research and experimentation have led Soviet scientists to evolve a three-vehicle system for the exploration of space. This consists of the orbital laboratory, Salyut-7, a vehicle of the Soyuz-T series to take the cosmonauts to and fro and a ferry cargo craft, of the Progress series. The latter brought to Salyut over one tonne of fuel and 100 other odd items for the recent Indo-Soviet space trip.

The space laboratory Salyut-7 orbits the Earth every 90 minutes at an altitude of 280 km. Its two cylinders are divided into four functional sections: equipment, working, rest and transitional. It becomes 30 metres in length and weighs about 33 tonnes when the Soyuz-T and Progress crafts are docked with it. The living compartment has a bedroom and a kitchen with a dining table with clamps for crockery. A psychological 'trick' is used to give the illusion of a floor and a ceiling (there being no floor or top in space). Also, it is possible to replace systems that are worn out, to take the orbital complex to higher orbits, to replenish the fuel in orbit and to turn or stabilise the craft, at will.

Several new features are incorporated in the Soyuz-T-11 space-craft. Though belonging to the Soyuz-T series, it is a totally new generation space-craft built on the modular principle. The new orientation system makes it possible to locate the Sun, the stars and the Earth at a great speed and to automatically orient itself accordingly. It can even fly past the Salyut station and choose a free-docking joint. A micro-climate, of pressure 780 mm/Hg and temperature 21°C, is maintained in the space-craft.

The Indo-Soviet space flight has far reaching implications, scientifically and politically. Several Indian organisations, the Indian Space Research Organisation, the Institute of Air Medicine run by the Indian Air Force, the Department of Meteorology and the Post and Telegraph will be greatly benefited by the results of the space flight. But the many dividends will be greatly multiplied in future.

The cosmonauts made 628 passes over India. Pictures from the space-craft will enable experts to track the hurricanes, demarcate flooded areas, monitor the growth and denudation of forest areas, watch crops, predict their yields and even the diseases which might affect them, provide continuous data on snow-melting and river flow, the onset of the monsoon, etc. Even the different types of trees will be identified in dense and difficult-of-access forests.

Remote sensing experiments are expected to reveal mineral-, oil- and gas-bearing sites. In the field of material science, the results are expected to find applications in the production of semi-conducting materials, super-pure crystals, solar cells and in the development of diagnostic aids for cardiovascular and vestibular disorders. Past experiments had revealed that several valuable raw materials and minerals are produced in space in conditions of weightlessness and deep vacuum. Already foam-metal, stronger than even high-quality steel and as light as wood, has been produced in space. Special mono-crystals used in semi-conductors, transistors electro-accoustics, high-frequency technology, optics, etc have already been produced in the zero-gravity environment of space.

On the biomedical front, experiments were planned to study the effects of the microgravity environment existing in space on humans. Studies on cardio-vascular deconditioning, space sickness and disturbance of motor functions were carried out, along with measures to counter the same. Effects of certain yogic *asanas* on problems typical of space travel (like increased blood flow in the head resulting in heavy and swollen heads, headache, giddiness, ossification of bony tissues, etc) formed a part of studies in space. The results will indicate the success or failure of the yogic *asanas* in overcoming space maladies. The yogic excercises performed every ten minutes by Rakesh Sharma were *Pranayama, Stithikarana, Vyayama* and the asanas *Padahasta. Parimitra Trikona* and *Ustra.* The experiments in biomedical sciences will further enhance our knowledge concerning the cosmonauts' psychic conditions, their capacity for decision-making, and the different ways to achieve self-control in space.

In short, this space flight heralds a new era for India, with wide and important implications in all walks of life—meteorology, geology, agriculture, medicine, physical science, etc. At present, about 1,200 research, design and production organisations of the USSR use space information. According to calculations, the use of this data amounts to a saving of 500 to 600 million roubles per year. India is specially suited to exploit this space-based information, in view of its agricultural economy and its dependance on monsoons. Let's march ahead.

males, which they did after scientists overcame initial difficulties of maintaining them in favourable conditions in captivity.

The existence of unisexuality in vertebrates raises some fundamental questions about how and why it happens. One fact that has been observed is that where the unisexual lizards exist, there has been, in recent geologic time, a shifting of climatic conditions and changes of plant communities. So the experts suggest that some time in the past the grassland species of whiptail interbred with the desert species, producing hybrids. As in the case with most interspecific hybrids, the initial crosses probably included both males and females, most of them sterile. At the same time the hybrids probably competed successfully with the non-hybrids in the mixed desert-grassland habitats. The first-generation hybrid males would have disappeared eventually, but any females capable of duplicating chromosomes in their ova would have perpetuated their kind.

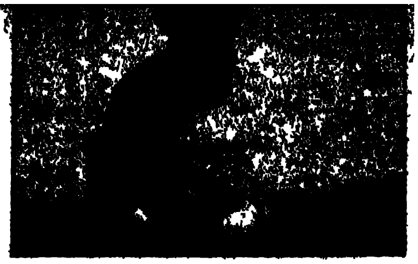
SIEMENS

Now the blind can be telephone operators

THERE is good news for the blind and the partially sighted. A new Braille manual, which can be read by both the blind and the sighted, increases their chances of getting employed in telephone switchboard jobs. A blind operator terminal converts the visual displays of the answering position into Braille, a system of raised dots which can be interpreted by touch.

The texts are composed of raised dots impressed into special thick, soft paper; the blind person reads them by feeling them with his fingertips. The very same text is printed in conventional form on the same page for the sighted instructor. Both trainees and instructors can thus grasp the subject matter at the same time.

The new manual is being developed in West Germany.



Ostrich egg—a hard one to crack

IN nature, a delicate balance between different life forms is constantly maintained. Any imbalances can have disastrous ecological and environmental effects and can even endanger the very survival of some life forms.

This is beautifully brought about in a recent study undertaken by Richard D. Estes, a behavioral ecologist from the US. Perplexed by the observation of the very existence of ostriches in hyenas and lion infested regions, Estes wondered whether the predatory habits of hyenas influenced the evolution of the size, shape and thickness of ostrich eggs.

During his experimental observations, he found a spotted hyena lying beside ostrich eggs carrying toothmarks of the hyena. To his surprise, the eggs were intact. He, then offered one of these eggs to about a dozen different hyenas. In spite of hyenas having sharp strong teeth and jaws that can bite through bones, they were unable to break open the egg. The jaws of hyena seemed to be short to get a grip on the egg. However, at times, hyenas are capable of destroying the entire set of eggs by rolling and crushing them with their forefeet.

Curiosity led Estes to test whether lions could eat ostrich eggs. An ostrich egg was placed near a group of four lionesses. Amongst them, an elderly lioness picked up the egg and settled down trying to open it up. She proceeded to pip it with one canine and scoop up the contents greedily with the tongue.

The second egg was placed in front of another group of six lions and lionesses. Unlike the elderly lioness, they ignored the egg completely unaware of the fact that the ostrich egg can be eaten. However, one of the lionesses toyed with it for sometime *(see above)* eventually giving up the game and moving away *(see below)* to attend to her business leaving the egg miraculously intact.

It is worth mentioning here that the ostrich eggs are the largest eggs that are laid by any living bird. Each egg is about six inches long and weighs over a kg. The egg is as good as a stone.

"Ostrich eggs for breakfast, and I'm always late for work!"

The ecologist, even after this experimentation wondered as to which predators could and did eat ostrich eggs.

To live in fear for ever...

HUNDREDS of young physicists are feverishly working at the Lawrence Livermore National Laboratory in California on the third generation nuclear weapons. These are weapons to destroy weapons. Included in this category are X-ray, laser and microwave weapons, and many others which are secret. Scientists are also working on developing an invisible protective shield to protect the US against a possible Soviet nuclear attack.

In the first generation of nuclear weapons came atom bombs, the second generation consisted of hydrogen bombs and the third generation falls into the 'star-war' category.

In its latest move, the US fired a new antisatellite weapon (ASAT) in space in January this year. This highly sophisticated ASAT was launched from underneath the wing of an ordinary F-15 fighter aircraft. This space-based defence system can destroy missiles in space. The test was immediately denounced by the American scientists, who consider this move a prelude to a dangerous new phase in the arms issue. Prominent American citizens who have criticised this test include Jerome Weisner, a former presidential science advisor, Hans Bethe, a physicist from Cornell University, Franklin Long, former associate director of the Arms Control and Disarmament Agency and Herbert Scoville, former deputy director of CIA The next step in the 'star-war' game is to install a space station. This move is being watched with increasing trepidation by the people.

These developments make one wonder whether we are damned to live in fear for ever. The development of third generation nuclear weapons by the superpowers, bodes ill for peace and the very existence of the world. So serious are the threats of a possible nuclear war, that different strategies are being worked out, some to prevent, some to avert and some even to fight it out. At the same time, a deep realisation is dawning on increasing numbers about the futility of a nuclear war—no one is safe, least of all the survivors.

It's only the 'fools and madmen' who think that a nuclear war can be 'contained', stopped before the world's deadly weapons are deployed. An article "Nuclear war, and climatic catastrophe—some policy implications" by Carl Sagan, a *David Duncan* Professor of astronomy and space sciences and Director of the Laboratory for Planetary studies at Cornell University, in the US, brings out in a masterly way the hopelessness of a nuclear explosion, both 'contained' and the one involving an outright nuclear war in any part of the world. Sagan's article of a 'nuclear winter' was based on a study conducted by 24 US scientists, all at Cornell. It has found near-universal confirmation and support, even from scientists in the USSR.

In Sagan's words, "Some of what I am about to describe is horrifying. I know, because it horrifies me... there are severe and previously unanticipated global consequences of nuclear war—subfreezing temperatures in a twilight—radioactive gloom lasting for months or longer... There is little question that our global civilisation would be destroyed. The human population would be reduced to prehistoric levels or less... And there seems to be a real possibility of the extinction of the human species".

As the war hysteria increases with deployment of more and more sophisticated weapons in the different parts of the world, there is a serious concern and some activism in the West, manifested in different ways. A new genre of war movies has been produced and in this category 'The Day After', has generated a spontaneous wave of anti-nuclear sentiments.

The Carnegie Corporation has started a new programme devoting five to seven million dollars per annum to involve more professional scientists in the prevention of a nuclear war. This programme, is intended to promote the sharing of information among weapon experts, political and behavioral scientists, policy analysts, both in and outside the government. As it is, several scientists have been actively involved, avocationally, in the nuclear arms issue. Now they will be paid some amount for what they are doing in their spare time, to reduce the risks of a nuclear war.

Strong peace movements are growing in all parts of the world. These are more pronounced in the UK and West Germany where the Cruise and Pershing II missiles have been recently installed by the US. Peace protesters in the UK have even been nominated for the 1984 Nobel Peace Prize. The people of these two countries are pressurising their respective governments increasingly and questioning their governments' decision to put the security of their countries in the hands of the US. NATO countries do not want to be caught midfire between the superpowers. Nor do they want Europe to be the hot-bed of a cold war. The memories of the Second World War are still haunting many. A more independent and a pragmatic defence policy is advocated by a large number of people. The USSR seems to have convinced them of its relatively peaceful intentions. The people argue that the image of USSR as an enemy No. 1 of western Europe is greatly exaggerated to create an ideological polarisation and to serve the interests of the US.

Peace efforts in India

A nascent peace movement has started in India too, though very slowly. Leading physicians of the country have issued a public statement and expressed fears about the possibility of a nuclear war. They have proposed the formation of an Indian doctors' organisation to mobilise public opinion against the consequences of such a war. The other prominent anti-nuclear movement is the Movement in India for Nuclear Disarmament (MIND) with its base in Bombay.

—B. S. Mahajan

Science and technology in Indian culture

HISTORIES of science and technology which have so far been written do not adequately represent the interaction of science and technology with culture, social values and philosophical ideas on the one hand and the economic structure and economic development in any given social system on the other. Further, they are highly Eurocentric and leave out the development of science and technology of non-European cultures and the latter's contribution to the world stream of knowledge and technological development.

Since the Second World War, Prof Joseph Needham's contributions to the understanding of the science civilisation of China and the studies in history of science and technology in Japan have brought out the extent of development of science and technology in these two countries. Recently, work on science and technology in the Islamic culture area has brought forth the richness of contributions made during the medieval period.

Somehow, the development of science and technology in India throughout her history has not been adequately represented. In the absence of the scientific and technological component, there has been an incomplete understanding of India's culture and civilisation and their contribution to the enrichment of world culture. Further, the introduction of science by the British in India is considered to be the beginning of science and technology in India and there is much dependence on the literature produced in the UK and the USA on the historical and social perception of science.

In order to develop a proper historical perspective and bring to sharp focus the development of science and technology in India and their relations with society, her culture, social values, philosophy and economic development, the National Institute of Science, Technology and Development Studies (a constituent of the Council of Scientific and Industrial Research) in New Delhi has initiated a significant effort and is organising a major programme under the title. 'Science and technology in Indian culture' The programme is divided into the following

Science and technology in ancient India (from the earliest times to the beginning of AD 12th century): This will trace the development of science and scientific thought in India in the perspective of the history of global science with the awareness of the complex interconnections of science with social organisation, technology, craftlore and belief system — the last as embodied in magic, folklore, religion, philosophy and jurisprudence. The purpose is not only to discern comparable contributions of Indian scientists with contemporary scientists in other civilisation but also to seek answers to the following queries: What did scientists in India contribute to the mainstream of world science? What did Indian scientists receive from this mainstream? Where and why did Indian scientists fail to be enriched by the scientific activities in other civilisations with which India had relations through trade, commerce, political and religious missions? Other factors which caused the decline of science in India will also be studied. There is also a project to study in depth the Indian tradition of maritime activities, navigation and nautical sciences in ancient and medieval periods.

Science and technology in medieval India (AD 1200-1800): In this theme, particular interest is being taken as regards the impact of Central and West Asian science on the Indian sub-continent. In addition to the development of science and technology, which was part of the Indian tradition, scientific ideas have percolated to the Indian society through Arabo-Persian scholarship. It is believed that this scholarship became a part of the Indian culture. How far this process has been successful will be investigated. The bulk of the historical literature for this period dealing with scientific and technological work is available in Arabic, Persian and Sanskrit. A few important texts have been selected for critical examination. The history of this period will be reconstructed to highlight the interaction between the development of science and technology in the various sectors of society. It will include the study of science and technology subject wise as well as interdisciplinary developments over different periods in medieval India. Finally, it will draw a synoptic view of the development of science and technology as a component of the cultural system. As a part of this study, an effort is also being made to study the introduction of Indian science and its impact on Arabic scientific literature.

> In the absence of the scientific and technological component, there has been an incomplete understanding of India's culture and civilisation and their contribution to the enrichment of world culture

Science and the Indian response in the colonial era: The introduction of western science and technologies in India specifically with reference to imperial motives and needs is being studied. While the establishment of various scientific surveys and explorations and the introduction of steam navigation, electric telegraph and railways, etc had some positive effects, it helped the British in creating an impression that Indian science and educational traditions were backward and gave rise to socio-psychological tension in the Indian mind. Here the objective is to analyse the way in which Indians reacted to the introduction of western science during the British rule, and to assess the impact it had on the emergence of scientific institutions, technological projects and industrial development. This study will be spread over two phases covering the East India Company (1965-1857) and the Raj (1858-1946).

Science and technology in post-independent India: The evolution of science policy in India is being subjected to an in-depth study. There has been a major effort to try to put together the information on science and technology development in India since independence. Considerable work has already been done particularly with regard to the evolution of science policy as seen from the speeches and policy statements on science and technology of Jawaharlal Nehru and Mrs. Indira Gandhi.

The INSTADS is initiating a major programme to study science and technology in Indian culture

'In this programme, the main thrust is being given to the development of research capabilities for achieving the take-off stage for developing research themes and studies. Presently, there are two main difficulties in the development of research capabilities. First, there are only a few scholars in the country who have the required expertise in the study of history of science and technology. The young historians are not much attracted to this field as it is not a traditional area of research. Two eminent historians, one conversant with the ancient period and the other with the medieval period, have been appointed as guest scientists to develop capabilities among young scholars. Second, the scholars are required to have a fresh look at the historical development of science and technology in India. Also, there are constraints as to the access to the basic sources for evidence. Access to such resources are to be developed through translation from classical languages and sufficient bibliographical work. Sources in Sanskrit, Persian and Arabic are being developed through translation of selected texts in English, Hindi and Urdu.

In addition, for the work on the history of science and technology in the Indian culture, a 'National Archives for Science and Technology' is being built at the institute. It is intended to locate, identify and retrieve science and technology information contained in the hitherto unexploited archival sources of the country and keep them at one place so as to make them available to scientists and technologists who would like to work on the development of science and technology in India as well as to planners, policy-makers, administrators, scientists and technologists through appropriate reference media.

A. Rahman

Dr. Rahman is Director of the National Institute of Science, Technology and Development Studies, New Delhi.

GOSH! IT'S NEITHER A SHEEP NOR A GOAT

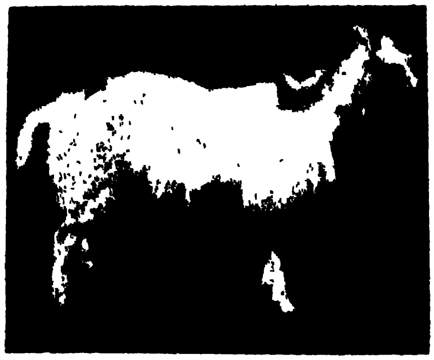
TAKE a close look at the animals in the photographs here Are they goats or sheep? Well, neither yet both. They are, in fact, sheep goat chimeras with characteristics of both these animals. The one on the left has mixed fleece, horns of a goat, but twisted like a sheep's, and blood with red cells of both sheep and goat. It behaves like a male goat but has proved infertile in natural matings with female goats. The animals on the right are sheep-goat chimera (standing) and its sheep twin (sitting). The chimera has hairy bands and patches on the neck and trunk, characteristic of goat hair. Otherwise the pattern of pigmentation in it is not different from that seen in its sheep twin

These weird animals are the results of techniques of manipulation of embryos and then subsequent implantations in female members of goat and sheep

In 1980, J Rossant and W I. Frels reported the production of rodent chimeras of *Mus musculus*-*Mus caroli* Hitherto, this has been the only published work where viable mammalian chimeras were produced by these techniques The two mice species were closely related, though not normally interbreeding Experiments with higher animals with very different genetic constitutions (like the domestic sheep -*Ovis aries*, 2n - 54 and the domestic goat, *Capra hircus* 2n = 60) which do not cross and produce viable offspring had failed

Two recent reports one from the UK and the other from Germany, published together in *Nature* (**307**, 634 and 637), seem to be the first successful attempts at producing interspecific chimeras Now the possibilities of producing offspring between diverse animals, like a cow and a horse or a zebra and a deer or a sheep and a goat do not seem remote

Though the development of embryos in different organisms vary in detail they fall into a broad pattern the fertilised ovum of an animal soon starts dividing in a characteristic manner four eight- multi celled stage and then a solid sphere of cells, called the morula is formed The cells continue to divide, a cavity forms giving rise to the blastula, a single cell-layered hollow sphere



Continued cell divisions lead to gastrulation and to subsequent evolution of the three tissue layers—ectoderm, mesoderm and endoderm. Later these three layers attain the structural and functional specialisation of the adult stage.

The team of scientists at the ARC Institute of Animal Physiology, Cambridge, UK. carried out three series of experiments on the embryos of goat and sheep. In the first and second series, single blastomeres or individual cells from 4-cell and 8-cell goat embryos were combined with blastomeres from similarly developed sheep embryos. These composite embryos were embedded in agar which held them closely together and then transferred to sheep oviducts for four or five days From there they were flushed out once again and examined for further development. Those embryos which developed into normally organised masses of cells were then transferred to the original females (sheep or goat) from which the blastomeres were taken.

In the next experiment, the inner cell mass and the polar nutritive cells from day-8 goat embryonic mass (blastocysts) were inserted into day-8 sheep blastocysts. Reciprocal embryo-manipulations were also made These cell masses were then transferred to sheep or goat recipients.

Different embryonic cell-combinations gave variable degrees of sheep-goat chimerism In short, sheep-goat blastomeres formed composite cell-masses which were viable and gave rise to offspring which were sheep-goat chimeras Also, a goat foetus could develop to full term in sheep and vice versa The high abortion rate or the low degree of chimerism encountered in some instances is attributed by the authors to a reaction of the recipient females against certain components of the chimeric embryo Further, the authors also claim that it is possible to completely neutralise incompatibility, the tendency to reject foreign tissue, between two different animal species This can be achieved by constructing the chimeric embryo such that, the growing embyonic mass' surrounding nutritional layer (trophectoderm) is made up entirely of cells belonging to the same

species as the recipients

The fact that the cell constitution of a chimeric embryo is of great importance in achieving full-term pregnancy in interspecies crosses, has been further demonstrated and confirmed by S. M. Tilmann and B. Meinecke of Institute fur Tierzucht Haustiergenetik der Justus-Liebig-Universitat, Giessen, and Ambulatorische und Geburtshifliche Veterinarklinik der Justus-Liebig-Universitat Giessen, Germany, in the second publication in the same issue of *Nature*. Interspecific chimeric embryos (sheep blastomeres of the 4-cell stage with two goat blastomeres of the 8-cell stage or two sheep blastomeres of the early 8-cell stage with two goat blastomeres of the late 8-cell stage) were transferred to an intermediate recipient and then again recovered and transferred to sheep recipients when they had reached the blastocyte stage. Only three of the total of 15 recipients gave birth to two sheep and one goat-lamb· one of the sheep-lambs was still-born. Chimeric features could not be seen in the offspring. Cytological and different blood and protein tests also did not indicate chimerism of the offspring

These experiments indicate that during embryo development a strong protective mechanism operates which normally prevents its ejection. In turn, this same mechanism rejects any foreign mass. However, embryo manipulation and its implantation can successfully overcome this barrier by proper design of the embryonic cell-mass to be implanted The recognition of a chimeric or a foreign embryo by the recipient can be prevented by choosing the right type of cells to construct the chimeric embryo The outer cells or those on the surface of the embryo which come in direct contact with the female recipient should belong to the species into which the embryo has been transferred.

The findings of this research will help in better understanding of the basic mechanisms involved in tissue rejection and other allied phenomena like species-barrier, etc. They may also help in producing new types of animals with sets of desirable characters.

B. S. Mahajan

What was advocated 2,500 years ago in *Charak Sanhita* is being said today about curds

Yoghurt reassessed

MANY people complain of diarrhoea and crampy abdominal pains on drinking milk. Once this was attributed to milk allergy. However, since the last 30 years it is known that this is not due to milk allergy but due to poor digestion of lactose, a sugar found in milk. Normally, lactose is digested by an enzyme, lactase, produced by intestinal cells. Lactase hydrolyses lactose to glucose and galactose. In the absence of lactase, lactose is not hydrolysed and remains in the lumen of the intestine where it acts osmotically to retain water. This retention and subsequent fermentation produces variable bloating, cramping, borborygmi and diarrhoea. The fear of crampy-pain and diarrhoea stops many adults from taking enough milk leading to protein deficiency and subsequent malnutrition. This is particularly true in populations which are vegetarian or which do not have enough to eat and drink.

Majority of children have enough lactase for the digestion of ingested milk. Usually, normal humans may become lactase-deficient by the first or second decade of their lives and hence lactose (milk) intolerance is more common in adults than in children. This normal decline in lactase activity is determined by an autosomal recessive mechanism and is not influenced by dietary lactose. Lactase deficiency is seen more commonly where people are already affected with a syndrome (tropical sprue), characterised by impaired absorption of food, water and minerals by the small intestine, or where the population is commonly affected with enteritis (inflammation of the intestinal tract), giardiasis (a type of diarrhoea), cystic fibrosis of pancreas, ulcerative colitis and other bacterial infections of the small intestine. Significantly, as many as 35 per cent (nearly one-third) of the normal Indian population is affected with lactase deficiency.

Curd and butter-milk use is common in Indian households and in south-east Asia. Only recently their use has increased in Western countries where very few can think of making curds at home, especially when several flavours of it are available in food stores. For the treatment of *Sangrahani* (tropical sprue, characterised by flatulence and diarrhoea), yoghurt and butter-milk were advocated as early as 2,500 years ago in the *Charak-Sanhita*. A recent report (*New England Journal of Medicine* **310** 84) confirms better absorption of lactose in lactase-deficient populations—they absorbed lactose in yoghurt better than lactose in milk.

The above report will definitely delight the yoghurt-lovers. Ingestion of 18 grams of lactose in yoghurt resulted in only about one-third as much hydrogen excretion as a similar load of lactose in milk or water. This indicates a much better absorption of lactose in yoghurt. The enhanced absorption of lactose in yoghurt appeared to result from the intraintestinal digestion of lactose by lactase released from the yoghurt organisms. This auto-digesting feature makes yoghurt by lactase-deficient populations and lactase deficient persons. This may also explain the widespread consumption of yogurt by lactase-deficient populations and in the West many adults who are not of northern European origin are lactase-deficient.

A large number of Indians are vegetarians with a low dietary intake of protein. These vegetarians could improve their tolerance of milk and intake of milk-protein by reverting back to yoghurt and butter-milk which *Charak Sanhita* advocated 2,500 years ago.

B. D. Pimparkar

Dr Pimparkar is a Honarary Physician and Gastroenterologist at the G S Medical College and the KEM Hospital, Parel Bombay

Carbon isotope in natural radioactivity

THOSE of us who believe that alpha is the heaviest particle emitted during natural radioactivity are in for a big surprise. H J Rose and G A Jones, scientists from the University of Oxford, UK, report (*Nature* **307** 245) that they have very good reasons to conclude that an occasional carbon-14 nucleus is also emitted as a decay product from radium-223 (Ra 223), normally believed to be an alpha emitter. This bizarre event, however, is so rare that only one was observed for as many as 1,000 million alpha emissions.

Prodded by a sixth—or fourteenth sense, the scientists set out to look for abnormalities in the decay of Ra-223. In an observation that lasted over several months, they were indeed able to identify the emission of a particle much heavier than alpha. Separating such events from a pile-up of alpha pulses was not an easy job. Using techniques familiar in nuclear experimentation, they were able to reject events due to pile-up, provided the individual alphas in the event were separated by over 100 nanoseconds. And the charge was identified unambiguously with a solid-state counter telescope.

Leaving aside experiments, does the theory of radioactive decay accommodate such unusual decay schemes? What are the chances for a particle like carbon-14 to form in the nucleus and subsequently escape from it? Quantum mechanics tells us that an alpha particle tunnels through the nuclear barrier.

Rose and Jones have applied such theoretical considerations to interpret their observed ratio of $8.5 \pm 2.5 \times 10^{-10}$ carbon nuclei per alpha particle and infer "the emission of carbon 14 from Ra-223 virtually selects itself out as the explanation of our data." They believe that similar by pass decays must be occurring in other nuclides of this region as well, more likely leading to the doubly magic nucleus Pb-208 and its neighbourhood.

Right now the question is whether similar studies will show up more such exotic decays, however few and far between they may be. What practical uses such decay modes could be put into will be the next question. Will this provide a means of dating geological samples remains to be seen.

Radiocarbon dating methods using carbon 14, now widely used for archaeological samples is based on measuring the concentration of carbon 14 in organic remains such as hair, bone, wood etc. Will this new mode of decay entail another correction for the initial concentration of carbon 14 for some of the samples used in radio carbon dating? It seems unlikely as uranium is present in such low levels as one part per million in rocks and one part per billion in the sea water. U 235 from which Ra 223 originates forms only a small fraction (.7 per cent) of it. Added to this is the rarity of the event itself which has escaped attention for over ninety years since natural radioactivity has been known.

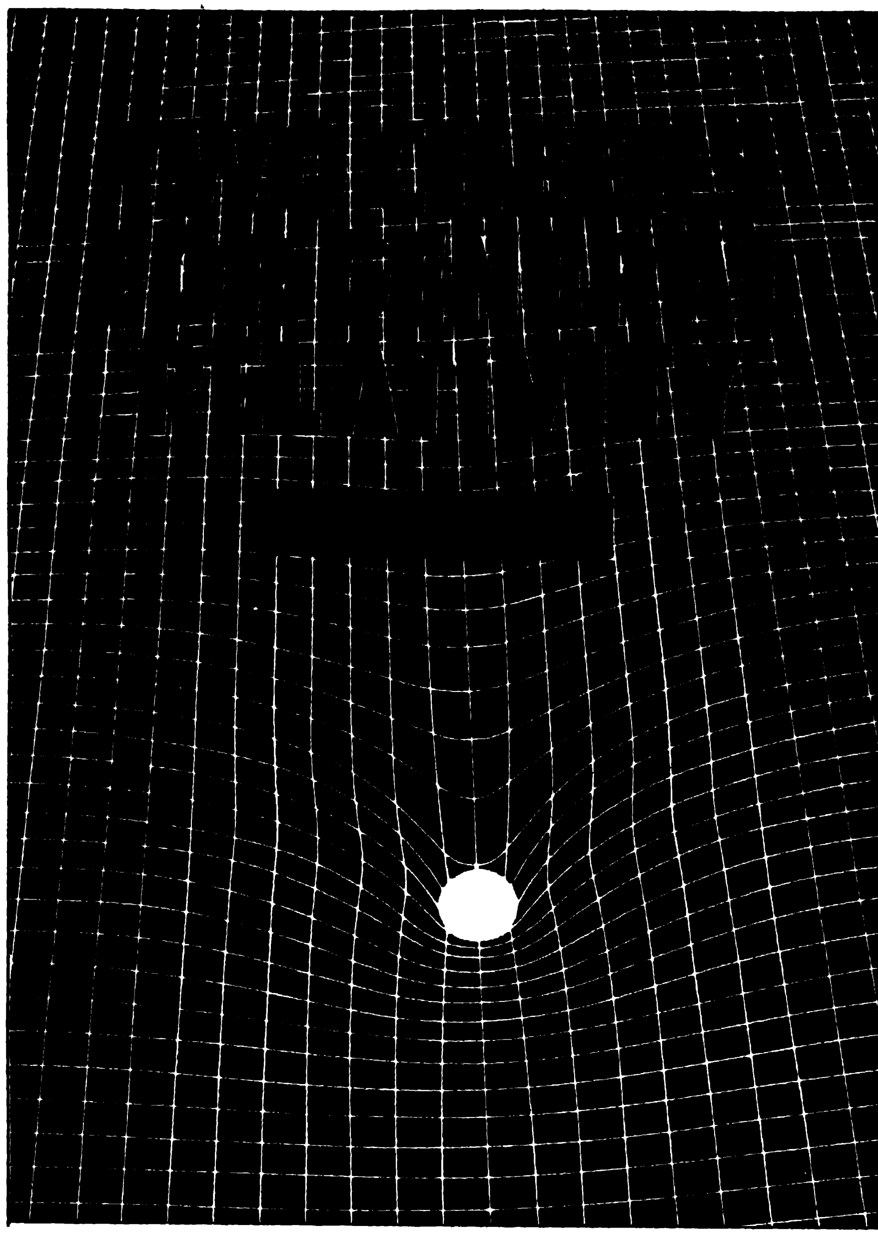
Indira Murthy

Dr. Murthy is on the editorial staff of Science Today

How has the theory of general relativity fared in the seventy years since it was propounded?

IN 1915, Albert Einstein proposed the general theory of relativity. The theory was the outcome of intense thinking on the part of its creator on problems of space, time, motion and gravitation. It is unusual for a physical theory to be born this way. Generally, a theory is born when experiments and observations show up some unexplained phenomena. Newton's law of gravitation (which general relativity was meant to supplant), for instance, came out of efforts to explain the observed motions of planets and the Moon. The electromagnetic theory took shape through constant interactions of theory and experiments. Even ideas on the special theory of relativity (Einstein's first major achievement of a decade earlier) were 'in the air' since the days of the Michelson-Morley experiment. But there were no such challenges which motivated general relativity.

Theories born in such isolation from the observational situation often turn out to be sterile and are soon forgotten. This year, general relativity enters its seventieth year. How has the theory fared in this interval which has seen dramatic advances in science on all fronts? What is left of it if we subtract away all the charisma and mystique built round it in Einstein's life time? To what extent has the theory contributed to the growth of theoretical physics at the fundamental level? And then the 'bread and butter question': 'how has the theory stood up to observational tests?' Let us try to answer these questions from the modern standpoint. But first, what is relativity all about?



In 1686-87, Isaac Newton published his famous treatise, *Principia* (The long title translates to *Mathematical Principles of Natural Philosophy*). This work laid solid foundations for physics – foundations that survived for two centuries. Of the several aspects that Newton covered, the two fundamental ones, the laws of motion and the law of gravitation, are of concern here.

The laws of motion describe how and why things move. Newton's laws tell us that all bodies in the universe possess the property of inertia because of which they resist any externally imposed changes of their state. Thus a body will continue to be in a state of rest or of uniform speed in a straight line if no external force acts on it. And if such a force does act on it, the resulting change of state is measured by the acceleration of the body. This acceleration, for a given external force, is large for a body of small inertia and small for a body of large inertia. You can lift a cat and move it around, but any force you exert cannot budge an elephant which has far greater inertia than the cat.

Now acceleration is the rate of change of velocity while velocity is the rate of change of position of the body. Naturally, to quantify these notions, Newton needed the concept of space and time. After spending an agonising time over these basic issues, Newton finally arrived at the concept of absolute space and absolute time. The idea

of absolute time is visualised by imagining a unique clock of nature which serves as the timekeeping device for all events and all observers. Likewise, absolute space provides the backdrop against which all velocities and accelerations are measured. These laws of motions worked well and thereby generated confidence, bordering on total faith, in the Newtonian system. What was forgotten was the fact that in the last analysis the Newtonian laws were based on concepts of spacetime that were assumptions, not absolute truths.

It was these assumptions that Einstein challenged when he proposed the special theory of relativity in 1905. Einstein argued that in concrete terms there was no unique backdrop that could serve as absolute space and so, in principle, all observers with uniform velocities relative to each other were equivalent in status.

He made a distinction between two types of observers: the *inertial* ones on whom no external force acts and the rest, *non-inertial* ones. Observers of the former category should, according to Einstein, have the same formal physical description of the universe The basic laws governing the electromagnetic phenomena do exhibit this feature, for example—provided we are willing to give up the Newtonian concepts of absolute space and time.

For a person, who is standing on a platform, the express train appears to move very fast as it rushes through the station. However, the same train, when viewed by a motor car driver moving along a parallel road, does not appear to move so fast; the observed speed of the train in the two cases is different. In the case of light, however, the same speed is measured by all observers even though they are moving relative to one another. This required a new rule of addition of velocities. Special relativity, in fact, provided the new rules on how spacetime measurements are to be made. And these rules required giving up the notions of absolute space and time. The resulting changes in the laws of motion were stated by Einstein in the 1905 paper and out of these

Isaac Newton

emerged the famous general relation $E = mc^2$ between energy and mass.

So much for special relativity. Where does general relativity come in? The general theory provided an alternative to the law of gravitation. According to Newton, gravitation is a property of nature that generates a *force* of attraction between any two material bodies. It is this force that drives the planets round the Sun and the satellites round the planets. Had there been no force of attraction between the Earth and the Sun, the Earth would have continued on a straight path with uniform speed as per Newton's first law of motion, instead of following an elliptical orbit.

Einstein's way of looking at the phemenon of gravitation was radically different. Einstein noted that since

Albert Einstein

gravity as an interaction operates between all material bodies, there is no part of space that is free from it. Nor can gravity be "switched off" in a given region, as electricity can be. This omnipresence of gravity can be understood if it is linked to another omnipresent physical entity: space and time. Einstein achieved this link by means of geometry.

Geometry as a subject deals with the measurements of spatial distances and angles. At school we learn Euclid's geometry not just because it is the simplest geometry but also because it has practical applications in everyday life. But there are other geometries, which do not follow Euclid's basic postulates. Theorems based on these non-Euclidean geometries can be quite different from those we are familiar with. For example, the theorem that the three angles of a triangle add up to 180° does not hold in non-Euclidean geometries.

Using these non-Euclidean geometries, Einstein proposed the hypothesis of "curved spacetime" that holds the key to general relativity. The basic idea can be illustrated with the Sun-Earth example. Why do planets go round the Sun in elliptical orbits? Not, according to Einstein, because of any "force" of attraction between them, but because the spacetime round the Sun is curved (p. 20) New rules of geometry apply here. The criterion of deciding "what is a straight line?" of course depends on what geometry we use. Einstein calculated that the geometry around the Sun is so different from that of Euclid's that planetary motion indeed is "straightline motion with uniform speed" according to the new geometry' To anyone looking at Fig. 1 this statement will appear incredible. But it happens to be correct. So general relativity "eliminated" gravity as a force but instead argued that the effects of gravity are manifested through the non-

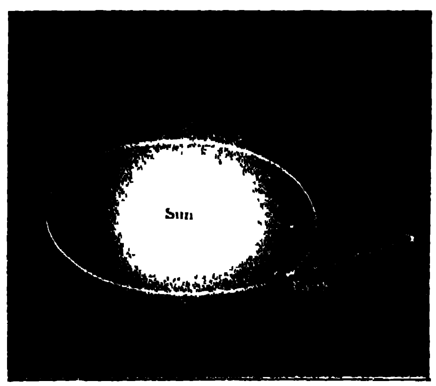


Fig. 1 According to Newton, gravitation is a property of nature that generates a force of attraction between any two material bodies. It is this force that drives the planets round the Sun; had there been no force of attraction between the Earth and the Sun, the Earth would have continued on a straight path with uniform speed. According to Einstein, however, the Earth is not going round the Sun because of any "force" of attraction between them but because the spacetime round the Sun is curved (see opposite page). Einstein calculated that the geometry round the Sun is so different from that of Euclid that planetary motion indeed is "straightline motion with uniform speed"

Euclidean geometry of space and time. This world-view separates general relativity from Newton's law of gravitation by a gap that is far wider than the gap that separated special relativity from the Newtonian notions of absolute space and time

Tests for general relativity

The progress of theoretical physics has by and large been gradual with a few glaring exceptions. The exceptions are highlighted by the discontinuous changes of concepts which suddenly magnify the physicist's vision. I can enumerate these exceptions since they are so few: the laws of motions and gravitation by Newton (1687), the unification of electricity and magnetism into electromagnetic theory by Maxwell (1864), the birth of quantum theory in 1900, the origin of special relativity in 1905 and that of general relativity in 1915

Even so, the jump of concepts from 1905 to 1915 was drastic. Although in general relativity Einstein used the concepts of *curved* space and time, a concept that was known in abstract form to nineteenth century mathematicians like Gauss, Lobatchevsky, Bolyai and Riemann, Einstein's originality lay in his appreciation that among all natural forces gravity was somewhat special and therefore needed a special treatment. His equations of general relativity give a quantitative description of how the elements of non Euclidean geometry of space and time are related to the distribution of matter and energy in it

We discussed how the planetary trajectories are regarded by general relativity. Fig. 2 illustrates the same concepts for a light ray. Suppose we take the path of a light ray as describing a straight line. In Fig 2(a) a straight line is drawn, *according to the rules of Euclid's geometry*, near a massive object. In Fig 2(b), a straight line is drawn according to the rules of non-Euclidean geometry that Einstein's equations prescribe. It does not look 'straight' to us since we are accustomed to Euclid's geometry.

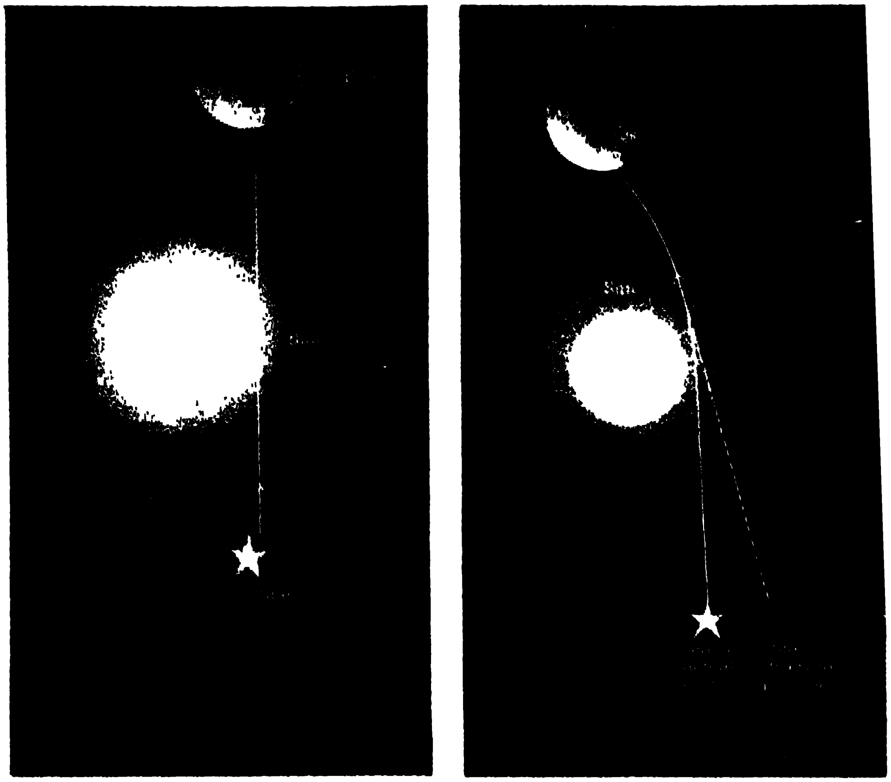


Fig. 2(a) The path of a light ray (discribing a straight line) near a massive object, drawn according to the rules of Euclid's geometry. In Fig. 2(b), a straight line is drawn according to the rules of non-Euclidean geometry that relativity prescribes; a light ray is bent as it passes close to the Sun

Clearly, the situation can, in principle, be tested. If the light rays from a remote star can be seen grazing the surface of the Sun, we can decide by looking at the star's image which of the two cases actually holds in practice. Of course, to be able to see a star near the Sun, the Sun must be totally covered, or we need a total solar eclipse for observations

How would such an experiment be performed? Suppose astronomers observe the position of a star continuously as the solar disc crosses its line of sight. When the ray from the star grazes the solar disc, it would be bent and the star's image on the photographic plate should show a marked displacement. From such a shift in the stellar position we can estimate the net bending of the ray.

This important fact was appreciated by the English astronomer Sir Arthur Stanley Eddington who was primarily responsible for organising such an experiment during the total solar eclipse of 1919. The observations taken at Sobral in Brazil and Principe in the Gulf of Guinea did confirm the picure 2(b). And with it Einstein became a celebrity.

In retrospect, judged by modern standards of observational accuracy, the 1919 result was far from decisive. There were many observational uncertainties in the actual measurements which made the result inconclusive. One major uncertainty was whether the bending was produced by the refraction of the ray while passing through the hot corona that surrounds the visible solar disc, or was it really due to the Einstein effect. Despite many observations after 1919, the result remained inconclusive during Einstein's life time.

However, studies using microwaves conclusively demonstrated in 1975 the correctness of the prediction made by general relativity. Microwaves from the quasar 3C 279 were observed and were found to bend (as measured by the shift in the quasar's location) by the amount predicted by general relativity. And the uncertainty of microwaves being bent by refraction is very small.

General relativity, in fact, offers very few observations that can be tested. What are the other possible tests, besides the 'bending' of light? Several decades of observations had shown even in the last century that the orbit of Mercury is not exactly elliptical as first found by Kepler by observations and as later explained by Newton using his law of gravitation. As shown in Fig. 3, the orbit as a whole slowly rotates in space. This is seen from the fact that the direction from the Sun to the point of closest approach (called the *perihelion)* slowly rotates in the same sense that the planet goes round the Sun. This phenomenon is called the advance of the perihelion of Mercury and its rate is estimated to be about 575 arc second per century. Why does it happen?

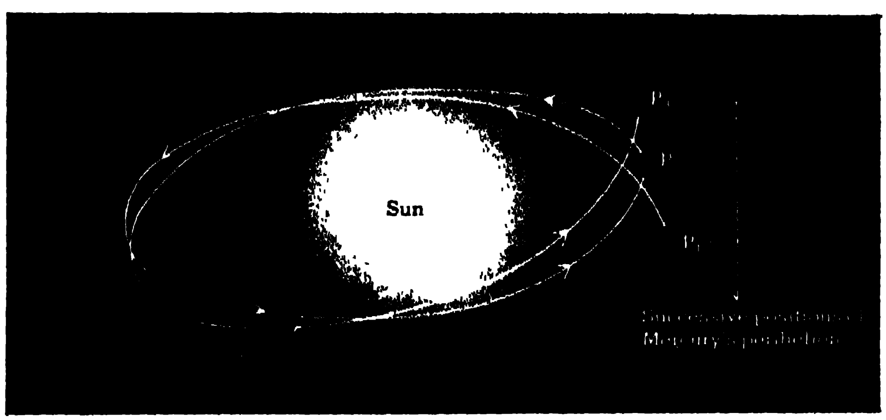
An arc second is an angular measure equalling 3600th part of a degree. The rate of perihelion advance for Mercury is therefore quite small (it is much smaller for other planets). Small though it is, it was large enough to worry astronomers in the last century like Le Verrier who postulated a new planet, which he named Vulcan, even closer to the Sun than Mercury. Such a planet presumably disturbed Mercury's orbit but the planet was not found. (This trick of postulating a new planet to explain the discrepancies in the orbit of an existing planet had worked earlier; in 1846, both Adams and Le Verrier had deduced the existence of Neptune from studies of the orbit of Uranus.)

Now the fact is, Mercury's orbit is also disturbed by other planets like Venus, Earth and Jupiter and their combined effect is to push the perihelion by about 532 arc sec per century. Thus Newtonian gravity accounts for more than 92½ per cent of the observed effect. It was the unaccounted 7½ per cent that was nagging astronomers like Le Verrier. General relativity clearly predicted that the Sun's effect alone should advance the perihelion of Mercury by 43 arc sec per century. Thus it fills the gap almost *exactly*. Indeed this agreement has been one of the feathers in the cap of general relativity.

I have always felt that this agreement between theory and observations is too close for comfort. There are at least two reasons for looking at the result more closely. First, if the Sun were not exactly spherical but were oblate like the Earth (that is, flattened at the poles due to rotation), then its gravitational force on Mercury is slightly modified. This small difference would contribute to the observed perihelion advance. Second, how accurate is the nineteenth-century theoretical value of 532 arc sec per century for the effects of other planets on Mercury's orbit? With highly accurate computer programmes now available and the improved estimates of values of planetary masses and distances, we should recheck this.

Recently my colleague N. C. Rana and I undertook such a computation. We had the advantage of a recently developed highly accurate computer programme by Sverre Aarseth at Cambridge. This programme computes how

Fig. 3 Mercury's orbit around the Sun slowly rotates in space and is not exactly elliptical.



a system consisting of many massive bodies evolves as the bodies move in one another's gravitational attraction. Thus we were able to apply the programme to investigate how the other planets influence the motion of Mercury. To our surprise, we found that the value is actually somewhat lower—530 arc sec per century. Thus the unaccounted balance does not match what is predicted by general relativity but leaves a gap of about 2 arc sec per century. This, we feel, could be due to the solar oblateness. Whether we are right or wrong, the above example illustrates the need for taking a fresh look at well-established old calculations using new techniques.

Another test of general relativity which has become possible through modern technology is the expected delay in a round trip radar signal when its path goes close to the surface of the Sun. Fig. 4 illustrates the experiment undertaken in 1975 with the help of Mariner spacecraft. As with the bending of light, the expected time delay of around 200 microsecond (1 microsecond = millionth part of a second) for microwave radar signals from the Earth to be reflected back from the spacecraft has been observed within 3 per cent errors limits. Thus another prediction of general relativity has been vindicated.

The bending of light, the advance of the perihelion of Mercury and the delay in radar signal echoes are the three tests which quantitatively substantiate the general theory of relativity. Is this evidence sufficient to generate confidence in the theory? I will return to this question later.

After Einstein

The charisma of Einstein and the awe in which he was held during his lifetime are typified by the following verse.

To Einstein, hair and violin,
we give our final nod,
Though understood by just two folks,
himself—and sometime—God!

In the early days of general relativity it was said that only three scientists understood the theory. The number 3 has no special significance and it could as well be 2, 6 or 10, depending on who tells the anecdote. It reflects, however, the mystique that had developed around the theory, which set it apart on a high pedestal.

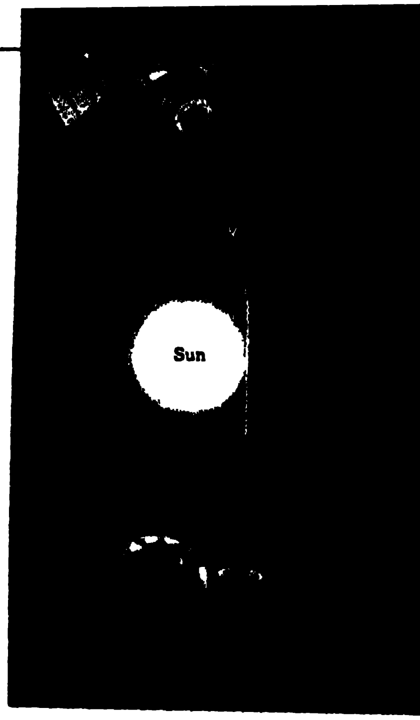


Fig. 4 The path of the microwave radar signal as it passes close to the Sun. The return of the signal to the Earth after reflection from the spacecraft is delayed fractionally

The situation changed dramatically in the two decades that followed Einstein's death in 1955. Rival theories grew up while the general theory itself was probed for new insights into the phenomenon of gravitation. The Brans-Dicke theory, the Hoyle-Narlikar theory and Dirac's theory are examples of alternative approaches to gravity. The inevitability of spacetime singularity, where the known laws of physics break down, the nature of gravitational radiation, black hole physics and the positive mass theorem are results to come out of general relativity in the post-Einstein era. Let us look at these post-Einstein developments briefly.

That rival theories for gravity should spring up is certainly a healthy aspect of current developments. Of these theories, the Brans-Dicke theory offered the strongest challenge to experimental techniques to distinguish between it and general relativity. The various tests in the solar system described earlier arose in response to this challenge and their verdict has been in favour of general relativity.

Both the Brans-Dicke and the Hoyle-Narlikar theories came out of attempts to incorporate Mach's principle in a theory of gravity—a principle that Einstein once regarded highly. Mach had argued that the inertia of matter (which we discussed in the context of Newton's laws of motion) is *not* just an intrinsic property of matter but that it owes its origin to the largescale structure of the universe as well (see box on p. 23). It was his failure to incorporate this principle into general relativity that eventually led Einstein to disillusionment with Mach's ideas. To those physicists who value Mach's ideas, the general theory of relativity will inevitably appear an incomplete theory.

Dirac's theory arose out of the mystery of the so-called large dimensionless numbers in physics. Why should numbers as large as 10^{40} appear when the microscopic properties of the universe are compared to its largescale properties?

Although general relativity was the first to produce viable models of the universe, this question remained unanswered. Dirac's theory attempts to explain it and out of such attempts emerges the result that the gravitational constant G is not really constant but should change with time.

Some models of the universe in the Brans-Dicke and Hoyle-Narlikar theories also make such a prediction. The estimated rate is small, of the order of a few parts in hundred billion per year. Atomic clocks coupled with astronomical observations of the Moon and the planets can in principle detect so small a variation. According to these theories, for example, there is small but detectable change in the period of the Moon's orbit around the Earth. Van Flandern of the U.S. Naval Research Observatory in Washington D.C. had claimed on the basis of his measurements of the Moon's positions as recently as in 1981 that G does appear to decrease with time at a rate of the above order. However, more recently, in October 1983, a detailed analysis of range measurements from the Deep Space Network in the USA to the Viking

[illegible] According to [illegible] future of the Sun is [illegible] the matter in the Sun [illegible] point, its density becomes infinite and, according to Einstein's equations, the curvature of spacetime becomes infinite too. Nobody knows what to make of [illegible] try to avoid [illegible] theories which lead to [illegible] general relativity be [illegible] of these infinities? [illegible] theorems tell us that infinities of the type encountered in the above hypothetical case of the Sun are inevitable for most forms of matter distribution including the universe, if general relativity is to be taken seriously.

J. V. N.

Lander on Mars led to the conclusion that G-variation, if at all present, must be considerably smaller than this predicted rate (no more than few parts in a thousand billion).

General relativity takes it for granted that G is a fixed constant of nature. A fixed G would therefore support general relativity, while a variable G would destory it. Can such an important measurement be performed in the laboratory free from astronomical ambiguities? Present day technology does hold out such a hope, but to translate it into reality requires high levels of experimental sophistication. The gravity experiments undertaken by R. Cowsik at the Tata Institute of Fundamental Research in Bombay are expected to achieve this.

Although each of these theoretical developments in the post-Einstein period ranks as a major achievement in theoretical physics, they have all highlighted the complex and, in some cases, highly intractable nature of general relativity. This present awareness may appear deceptively similar to the early reputation of general relativity as a "difficult theory". Deceptively, for in the second decade of this century physicists found general relativity difficult because they did not understand it while in the present times they find it difficult because they do understand it.

For example, the work of the late 1960's leads one to the conclusion that spacetime singularity is an inescapable feature of general relativity (see box above). A singularity in this context means a break-down of the laws of geometry of space and time including measurements of spatial distances and time intervals, which are so inherently essential for. description of gravity. What should one make of a theory which leads inevitably to a break-down of its own fundamental postulate?

Unlike electromagnetic radiation which led to a much better understanding of electromagnetic phenomena, gravitational radiation has only led to an awareness of how complex the phenomenon is in general relativity. Take a simple example in electromagnetic theory. When a wireless transmitter is switched on, it emits electromagnetic waves. These waves continue to be emitted until the transmitter is switched off—after which there are no more waves. Not so in gravity! Experts in gravity have still to produce a mathematical description of what is meant by the switching on and off of a transmitter of gravity waves. The mathematical solution which works for the electromagnetic transmitter does not give a clue to the answer in the case of gravity waves.

For the last two decades, black holes have been a popular field of research in general relativity. A black hole is an object which is so highly compressed that even light is gravitationally pulled back from its surface. In other words, such an object will be invisible. Its presence could nevertheless be deduced from the strong gravitational pull it exerts on its surroundings. Do black holes exist in the universe? The answer is "yes" if you are to be guided by conjectures and mathematical extrapolations of what is known and observed, and "no" if you are asked to produce concrete evidence. Elegant and beautiful though it is, much of the work on fundamental properties of black holes refers to areas which have neither been tested by observation nor are likely to be tested in the foreseeable future.

Two factors have contributed to make the general theory so difficult to handle. And, ironically, both are considered its merits also. One is the property of gravity that it is a manifestation of spacetime geometry. Thus when situations of changing gravity are encountered, one does not know whether to look at it purely as a state of changing spacetime geometry or identify part of the effect as that of a changing gravitational force. For example, one expects two stars going round each other in a binary system to radiate gravitational waves. Normally one visualises a wave as travelling in space. But how does one characterise a wave that is also a manifestation of the changing nature of space itself?

The binary problem is useful in illustrating the second difficulty also. The two-body problem which is the basis of Newton's inverse square law of gravitation has not *yet* been solved rigorously in relativity. Approximate solutions exist for describing binary systems but these do not help in telling us how gravitational effects vary when two highly compact stars (or black holes) go round each other in closely bound orbits. The reason is that Einstein's equations are what mathematicians call *non-linear*: the gravitational effects of a two-body system cannot be obtained by simply adding up the effects that each of the two bodies would produce in isolation.

Finally we come to Einstein's unfulfilled dream—the goal of a unified theory. Einstein strongly believed in unifying all basic forces of physics, although when he put forth the general theory of relativity only two—gravitational and electromagnetic—were known. So it was not surprising that he should proceed to unify the two within the framework of non-Euclidean geometries for space and time.

That he did not succeed could be due to several reasons whose correctness or otherwise will be established only when unification finally succeeds. Partly he failed because he was attempting unification at the classical level when, as is now realised, most of fundamental physics manifests itself at the quantum level. In particular, quantum electrodynamics, the weak and the strong interactions, are revealing new facets of nature at the microscopic scale only. Einstein's attempts were at the macroscopic level where these facets are smeared out of existence. Current

Continued on p. 62

READ, REFER and RESPOND

Vidya Dhar

THE suffix "re" usually connotes repetition. "Re" is also favoured by reference assistants and researchers (as an avatar of the Latin *res* which signifies a thing or the matter being referred to). However, in science *re* can also have more than these two connotations, as you can see from the appended list of ten words. *Re*flect on them, *re*ad, *re*fer if necessary and *re*spond to us! Answers on page 75.

(1) Regeneration:
(A) Renewal synthesis of a gene
(B) Replacement of an severely injured tissue
(C)The later generation

(2) Regression:
(A) Motion in reverse
(B) Psychological aversion to aggression
(C) Mean expectation of one variable relative to other.

(3) Renal:
(A) Pertaining to anal aperture
(B) Pertaining to kidney
(C) Pertaining to alimentary canal.

(4) Reagin:
(A) An intermediate in the synthesis of alcohol
(B) An antibody responsible for allergic manifestation
(C) A harmone responsible for the ageing process

(5) Realgar:
(A) Natural Agar
(B) A substance secreted by algae
(C) A mineral ore

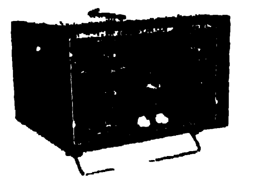
(6) Relaxin:
(A) A hormone found in the serum of pregnant female
(B) A laxative of plant origin
(C) A doped impurity which relieves structural stress

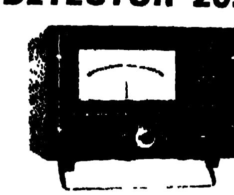
(7) Reamer:
(A) An instrument to count reams of paper
(B) An instrument to measure nonhomogeneity in glass
(C) A tool used to shape a hole

(8) Recessive:
(A) A soft pliable material
(B) a gene allele wqhich is not expressed
(C) A polymeric molecule which undergoes repeated scission

(9) Rectilinear:
(A) Resulting from the perimeter of a rectangle
(B) Pertaining to muscles lining the rectum
(C) Consisting of or bounded by lines

(10) Refractory:
(A) Resistant to a treatment or stimulus
(B) Congenial to repeated fractionation
(C) Capable of causing refraction





ULCERS: The pain in the gut

GOOD morning, Mahesh. Come in. Now, what brings you here?

Doctor, I have this pain in the pit of my stomach (pointing to top central portion of his belly) *for the last four to six weeks. In the beginning, it used to subside for a few hours when I ate something, but lately the relief has become short-lived. Also, the intensity of the pain has increased. Sometimes I wake up in the middle of the night and have to drink a glass of milk before I can go to bed again. I was hoping that the pain would subside on its own, and now my family physician has advised me to consult you before it is too late.*

Well, it is good that you have come now. First tell me something more about your pain. Can you remember anything special which might have triggered the present problem?

Come to think of it, there were many things on my mind for the last few months. Our company is passing through difficult times. I was working overtime. My meals had become irregular, and my smoking and coffee intake had considerably increased. Just before this pain started, I had come down with severe flu. It was treated by my family physician with aspirin and some other tablets. But I cannot really ascribe my pain to anything in particular.

Do you have any other trouble, besides the pain? Any vomiting? Have you noticed any change in the colour of your stools? Have you felt any ball like structure moving inside your abdomen? Do you feel any pain in your back or right shoulder?

I do not think I have any one of those symptoms. But, sometimes I do get sour eructations which leave a burning sensation in the midline of my chest.

Have you undergone any investigations before?

No, not for this pain.

What treatment have you taken during last four weeks?

I have been really medicating myself. I have been taking antacid tablets whenever the discomfort was intolerable.

Did you have a similar problem before?

Yes, doctor. Three years ago when I was on a business tour I had a similar problem. It lasted for about four to six weeks. At that time, I had consulted a doctor who had told me that I was suffering from an ulcer in my stomach. He had put me on milk diet and antacids and advised me to cut down on my drinks and cigarettes. To be truthful, I followed his advice for some time but when I felt well I could not adhere to these restrictions. But, I have done reasonably well during the past three years. Except for occassional discomfort, particularly after a heavy meal, there was no problem. That too used to promptly respond to antacids after a few days. But this time it has been a different story.

Will you please remove your coat and shoes? I would like to take your weight. Your colour looks fine. Your pulse and blood pressure are also fine. Now let me have a look at your tummy. Can you point to where you feel the pain? Is it tender here?

Yes, it does hurt.

Thank you. You can dress up. Let me explain your problem to you. I think your ulcer has recurred. There is nothing to worry about it. It is very common for peptic ulcers to recur because it is not easy to alter either your personality or your habits. I am very hopeful that we shall be able to control your problem by medical means and with your active co-operation we might be able to prevent its recurrence. But first I will like to get some tests done.

What are these, doctor?

The first is a measurement of haemoglobin and a stool examination for occult blood to exclude any blood loss from the ulcer. The second is a good radiological examination with barium meal to identify the site and size of the ulcer. If the latter is inconclusive, I may have to get a gastroduodenoscopy done to be sure about the diagnosis as well as to confirm at a later date that the ulcer has healed.

What is this gastroduo........?

It is a procedure of visualising the inside of the stomach and duodenum with a instrument, like a telescope. For this, you will have to swallow a flexible tube which is approximately as wide as your thumb. The procedure can be easily done by spraying an anaesthetic in your throat. It is safe and takes only a short time. You can return to your home after the procedure is finished.

But doctor, what is this peptic ulcer?

Any ulcer (just like a wound on the skin) on the inner lining of stomach and duodenum (or at lower end of the food-pipe) which is bathed with an acid and pepsin (contents of the stomach secretion), is known as a peptic ulcer. Usually a peptic ulcer is single and chronic. It occurs either in the stomach (gastric ulcer) or in the duodenum (duodenal ulcer). But ulcers may also be acute and multiple, superficial abrasions of the stomach. Although, both gastric and duodenal ulcers are labelled as peptic ulcers, the clinical course, outcome and specific therapy differs for the two kinds of ulcers.

How are these ulcers produced?

I wish I could tell you the cause of this disease, but unfortunately, modern medicine still does not know all the answers. All

X-ray showing duodenal ulcer (left). Ulcer of the stomach is seen on the right. The epithelium lining of the stomach has been eaten away by the ulcer

Ulcer formation crosses all socio-economic and occupational barriers. But for its formation, the presence of an acid and pepsin is essential

that we can say is that there are some predisposing or precipitating factors. But then the information that is available is quite useful to prevent the recurrence of ulcers. The control of these factors also helps in the healing of ulcers
helps in the healing of ulcers.

Although peptic ulcer is often quoted to be a classical example of psychosomatic disease, it has been reported to cross all socio-economic and occupational barriers. The presence of acid and pepsin seems to be essential, but why all individuals do not develop peptic ulcer may be related to mucosal resistance A variety of stimuli may stimulate gastric acidity. These include certain neural stimuli such as sight, smell or thought of food (through the same mechanism anxiety and stress may enhance gastric secretion), as well as chemical stimuli including certain food items such as tea, coffee, alcohol, tobacco, etc Cigarette smoking is an important contributory factor in the causation of duodenal ulcer A number of drugs, particularly aspirin (and other anti-inflammatory agents) and corticosteroids are notorious for producing ulceration. In certain diseased states also, the incidence of peptic ulcer is high

Thank you, doctor. I am prepared to do as you say, but I must get back to work as early as possible.

O K, then here is your prescription. It starts with a list of don'ts

(1) No tea, no coffee, no alcohol, (2) no peppers, red, green or black, (3) no smoking, no tobacco, and preferably no *pan masala* either, (4) no hurry, worry or curry, and (5) no aspirin, etc particularly on an empty stomach

If you follow all these don'ts then you can eat anything you like. You do not have to take milk and milk alone. The meals must be frequent (preferably at two hour intervals to begin with—they can be spaced at a later date), they should be small and bland For this, you do not have to stay at home You can take some milk, biscuits, sandwiches and ripe fruits with you You can eat *chapatis* or rice and can also take baked or boiled meat, etc And you have to take only one medicine. It is an antacid It is preferable to use it in a liquid form But you must take it in the quantity prescribed and remember that you should take it one hour after meals.

This diet and drugs must be religiously followed for six weeks, even if your symptoms disappear in few days

Why have I to take the prescribed quantity of medicine after meals only?

The mainstay of our therapeutic approach is to neutralise the acid production by the stomach. The food itself acts as an antacid in the beginning, but later more acid is produced in response to it. It is for this reason that we prescribe antacids one hour after meals and also advise frequent meals

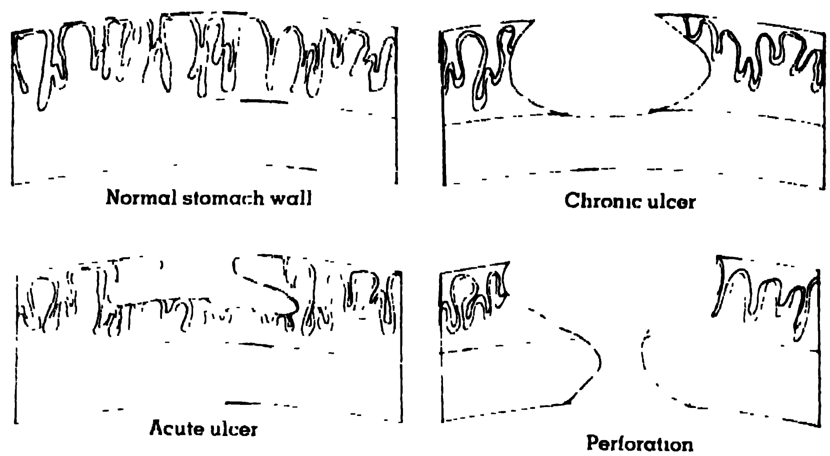
The exact amount of antacid required varies for person to person and brand to brand of the antacid, but it has to be sufficient enough to keep the pH (a measure of acidity) inside the stomach above 3 5 all the time.

But does this large amount of antacid cause any side effects or toxic effects

Properly chosen antacids are almost free from any side effect The most common problem with antacids is that in some they may produce either diarrhoea or constipation However, this can be controlled by changing the antacids Soda bi-carb and calcium carbonate are not recommended for long term use Regarding infrequent side effects, one must remember that all drugs are double edged weapons However, judicious use (where benefits are more than risks) under close medical supervision virtually eliminates all risks

Isn't there anything better and quicker?

Of course, there are other medicines but I do not think that they are either better or quicker A carefully chosen antacid in adequate dosage may heal 80 per cent of the ulcers in four to six weeks time



A stomach ulcer forms when the strongly acidic gastric juice, produced by the gastric glands, erodes the stomach lining. An acute ulcer forms when the epithelium lining is destroyed. Left unchecked, even the muscle layer may be eaten away causing chronic ulcer. Eventually, the ulcer may perforate the stomach wall

Suppose, I do not get better with this treatment, what else can be done?

There has been one dramatic development in the treatment of peptic ulcer and that is the discovery of a new drug called cimetidine. It is a very effective drug and can be useful even where antacids have failed. The dietary precautions have to be similar with cimetidine as with antacids and cimetidine also takes four to six weeks to heal the ulcer. Its success rate is also about 80 per cent. Even though it is a good drug, it is not necessary to use it in all the cases

Can ulcers be surgically cured?

In my opinion the role of surgery should be limited to complications or where medical treatment has completely failed

What are these complications which may require surgery?

There are two major complications of peptic ulcer One is bleeding from the ulcer, resulting in vomiting of blood (haematemesis) or passage of black-tarry stools (malena) The second major complication is that of perforation The ulcer may also penetrate locally or produce an obstruction to the emptying of the stomach

Thank you doctor You have really removed all my doubts

S. S. Agarwal

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Nature has lavishly endowed all creatures with a variety of ways of communicating: gesture cues, sound cues and scent cues, the latter apparently being dominant in the majority of species

ANIMALS's extraordinary sense of smell, their unaccountable instinct for finding directions and their ability to see the invisible and hear the inaudible have long been at the focus of reaserch An animal's capacity to orientate itself is still poorly understood, and has been regarded as an enigmatic "sixth sense". Investigations into what these capacities are involve a wide range of biological problems from the simplest chemical reactions to the most complicated phenomena, such as natural sonars (active and non-active), polaroids, solar compasses, and the sophisticated "choreographic" communications that have been discovered among bees. Of special importance among these problems is chemical communication, that is, exchange of information via odours.

It is well-known that animals depend on their sense of smell to track down and chase prey, to find a mate, to distinguish between strangers and members of their own species, and to be informed of the presence of danger. But how do odours contribute to communication? Does their communication system have a parallel in human language? Is that true that information exchange among animals is in some way similar to speech in humans? And are there grounds to believe that animals have a language of their own?

A language of odours

According to the Soviet linguist Prof Yu. Stepanov, the question as to whether an animal language exists and in what way it would manifest itself, should not be posed that way, it is rather that the very instinctive behaviour of animals is a kind of language based on a lower order of knowledge. Amongst the gamut of language or language-like phenomena, it is nothing but a "language of low degree"

Yet, some twenty years ago, this approach would have seemed unrealistic. Today, extensive studies on the behavioral mechanisms in insects, fish, birds, bats, rats, and whales have deepened our insights into the possible ways animals communicate with each other, and new dimensions have opened up. Until recently, only two types of signals were studied: optical signals, that is, those perceived by the organs of vision and acoustic signals, those perceived by the organs of hearing. Today the chemical signals as perceived by the olfactory and gustatory organs are at the focus of attention too. As a rule, animal-secreted odorous substances propagate over fairly large distances, are active in the dark, and can persist even after the sender disappears. This renders them superior to the signals of the first two groups.

The information encoded in chemical cues and perceived by the olfactory organs is frequently decisively important for many behavioral acts. Evolutionarily, this kind of communication is the most ancient signalling system which is found in all living organisms (chemical signalling has also been discovered in bacteria, algae, fungi, and the higher plants).

It is not known exactly when living organisms first came to detect odours (molecules of special chemical compounds). It appears to have occurred many thousands of years before aquatic dwellers abandoned the oceans. Swimming in the primeval ooze of the Archean seas which covered the Earth at that time, they must have been able to respond in some way to water-dissolved chemical substances, to search for edible compounds, to escape from hazardous agents Biological evolution saw increased sophistication and specialisation of this chemoreception as it came to play a decisive role in all animal behaviour

An interesting concept about the role of olfaction in evolution has been advanced by the Canadian scientist R. Wright, who is known for his long experience in the field. In his book, *The Science of Smells*, he writes, "If the function of the brain is to regulate the activities of the organism on the basis of information received, it almost looks as though intelligence had its beginning as an apparatus for handling olfactory signals from the chemicals which bathed our first progenitors in the primeval ooze."

Specialists believe that of the vast amount of information received by human sense organs from the outside, olfaction accounts for no more than one per cent. In animal interactions the olfactory organs frequently play a dominant role. In contrast to man, many animals take decisions exclusively on the basis of odour. Their scent memory is even more developed and their sensitivity and selectivity to particular odour components of animal secretions are just short of fantastic.

Relationships in the animal kingdom are impossible without information exchange between individuals. However, the transfer of information, and naturally it is reception by the individual to which it is addressed, cannot be accomplished without known interactions, that is, signals of different ranks and complexities between the recipients. Nature has lavishly endowed all creatures with a variety of ways of communicating: gesture cues, sound cues, and scent cues, the latter apparently being dominant in the majority of species.

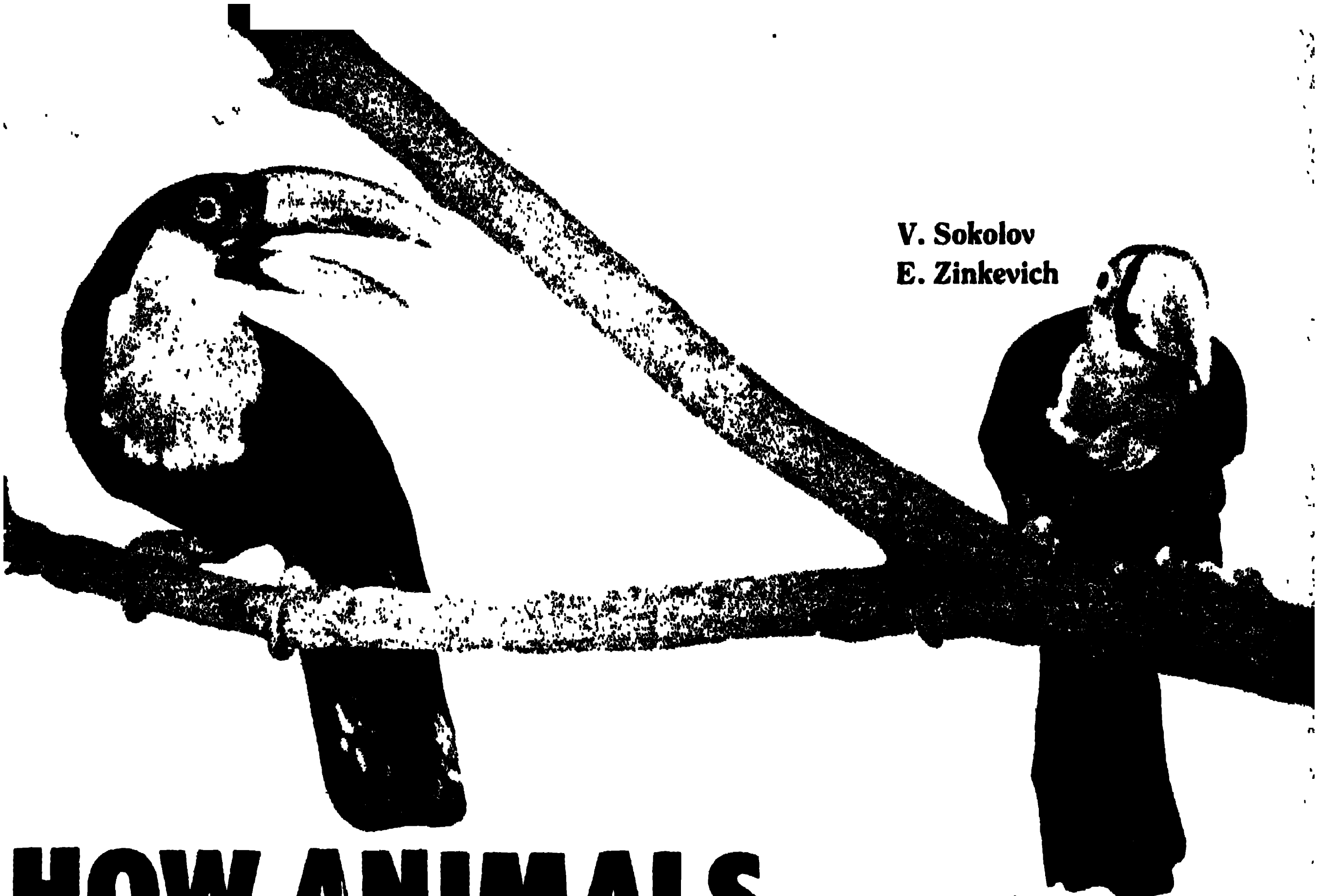
The outside world is literally filled with odours, which are signals: thousands of challenges, warnings, promises, and orders are being communicated every second. The olfactory communication channel operates without interruption.

First discovery

The first chemical communication agent to be described was bombycol. This comparatively simple organic compound—an unsaturated aliphatic alcohol with 16 carbon atoms—is used (in very low concentrations) by the females of Chinese silkworms to attract males and was extracted and subsequently synthesised 24 years ago by A Butenandt, a Nobel Prize winner at the Max Planck Institute, Munich.

Actually, that was the first "word" to be deciphered in the language of scents and the start of dictionary of odours. Today over 200 insect pheromones are known. Fine filaments of scent bind together members of the same species of butterflies, beetles, flies, dragonflies, ladybugs, mosquitoes ... in fact every creeping and flying member of the invertebrates. They respond to a scent cue even if the sender is a few kilometres off and the pheromone concentration is minute, about 10^{-15} gm/cc of air (millions of times lower than the concentrations detectable by the analytical instruments used in chemistry). Today, the insect dictionary available is not very voluminous but it does consist of a few chemical words which, in most cases, are used very effectively.

Information exchange between mammals, animals with more developed nervous systems, is organised differently. For them a chemical cue is not a command but a piece of information to be assessed in a



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HOW ANIMALS COMMUNICATE

given situation. The more advanced the nervous system, the more complex and flexible the animal's behaviour.

In the Laboratory of Morphology and Ecology of the Higher Vertebrates, IEAME, intensive research is under way on house mice, Norway rats, wild boar, mink and other animals.

The studies are being conducted in a number of directions. The scientists are interested in: firstly, the sources of pheromones; secondly, the structure of the chemical compounds concerned; thirdly, the biosynthesis of pheromones; and fourthly, the responses of animals to chemical cues. Last but not least comes the fifth direction—the most obscure but undoubtedly promising avenue of studying the development of techniques of animal management.

One very acute problem is whether the technical and intellectual resources now available will be sufficient to decipher, in the near future, the language of an animal species. Researchers are confident, however, that simple phrases like "we are of one blood", "I am a female in estrus", "danger", "I'll kill you", etc, will be translated very soon from the animal language into human.

But what are pheromones?

Their most common feature is that they are biologically-active substances. In small doses (fractions of a milligram) they considerably influence an organism's vital processes, whilst the typical biologically-active substances, such as hormones, neuromediators, narcotics, and poisons, affect an animal's metabolic processes from the inside and in a largely nonspecies-specific way; signalling substances which stimulate the external specialised chemoreceptor system to modify in a species-specific way an organism's behaviour, physiological and emotional state.

A pheromone is a set of substances (or in the simplest case a single substance) among the numerous components released by an organism into the environment. Provided certain external conditions are met and the inner state of the animal is appropriate, odoriferous agents can modify its behavioral and physiological responses. They are received via external chemoreceptors, primarily the olfactory system, though the gustatory receptors can be involved, too.

Pheromones, which are species-specific agents, in some cases may have an interspecies effect when animals from one species obtain information about an individual belonging to another species. Behavioral responses to pheromones may be both inherited and acquired through experience and learning. Responses may vary depending on the situation and the individual

characteristics of signal-receivers.

Communication of chemical cues is based on the contact of the olfactory surface with pheromones. The latter appears to trigger off certain biochemical and physiological processes and their inter-action with the receptor system can be regarded as an informational inter-action.

The cue is transmitted by substances which the animal secretes either on its body surface or on some other surface. The cue itself consists of volatile substances in an evaporated state, the receiver is an olfactory organ, and channel "noise" consists of the irrelevant, volatile substances in the environment.

Volatile mixture

What is a secreted mixture of volatile compounds? It is nothing but a message being sent without a particular address. Its chemical composition encodes certain information but the information's importance is determined by its relevance to the species' survival (information such as species, sex, individuality, sex maturity, estrus, etc). Every individual component or a combination of components in the message, and also the relative and/or absolute contents may serve as code elements. Information about physiological changes of an individual may possibly be contained in the sweat or urine, since the excretion products of a system quickly respond to internal and external disturbances. Correspondingly, slow-changing or unchanging information is communicated by excretions from the inertial system, e.g., those from the sebaceous glands. As soon as cue substances reach a receiver's sense organs, the recipient gets a sort of shock—information transferred via nerve impulses to the brain. When the information has been received the individual instantly re-orientates its behaviour, making it ready to escape or attack, defend itself or meet the stranger amicably. The nature and source of the cues received account for the complex patterns of inter-action that occur between the numerous members of the animal kingdom.

Our experiments have demonstrated the decisive role scents have for the behaviour of house mice. When a male house mouse encounters a strange male in its territory, he flies into a rage, and starts chasing the intruder in order to kill him. If however, the newcomer has spent time in the host's scent environment prior to the encounter, the host remains quite peaceful. Take another example, if a female is approached by a strange male when the host is absent, the latter batters his mate on returning, and remains furious until the strange scent fades away.

It has been found that the physiological and emotional state of the mice is changed by the effect of a particular scent or pheromone.

However, before an account of our experiments is given, let us turn to the structure and nature of pheromones.

The chemical composition of the secretions of only one per cent of the 4,014 mammalian species ever described have been investigated. In addition, the complete composition, qualitative or quantitative is unavailable for even one specific skin gland.

The outer surface of a mammal's skin is known to be covered with a thin fatty layer formed largely by the secretion of nonspecific sebaceous and sweat glands. The composition of "wool fat" has been studied in detail only for sheep. Besides the nonspecific sebaceous and sweat glands all mammals have a number of different gland types and their odoriferous secretions can accumulate both on their surface and in the skin fosse and recesses. Normally, secretion is at a maximum during the breeding period, occasionally being as much as several grams per individual.

Specific skin glands are classified according to their position and secretion type. Thus Artiodactyla reindeer for example, have well-developed interdigital, prepucial, tarsal, audal and preobital glands while Carnivora have well-developed anal and sole glands and some rodents have midventral, lateral, sole glands, glands in the corners of the mouth, etc.

An examination of a mammal's skin surface shows that different areas contribute unequally to chemical secretion. In addition, the animal's metabolic products, containing largely nonvolatile components, are subject, when passed into the environment, to the impact of physico-chemical factors such as moisture, oxygen, ozone and radiation. Some additional components appear to be due to microorganism activity in specific skin glands. As they are accumulating in skin recesses and heated by the animal's warmth, its secretions promote the growth of certain microorganism species which process high-molecular substances to yield molecular odoriferous compounds including semiologically-relevant ones. (Semiology, branch of linguistics concerned with signs and symbols).

A mammal's specific skin-gland secretions are composed of a very diverse variety of substances. Waxes and glycerols, plasmologens and free fatty acids (including low molecular weight ones), macrocyclic alcohols and ketones, and nitrogen and sulphur-containing compounds—this list of chemical constituents of a secretion is far from complete.

What is a pheromone like? Let us try to describe it. First, it is a combination of members of certain classes of organic compounds, though their structure cannot always be fully determined even using sophisticated techniques. Secondly, it is an odoriferous substance (about 20 per cent of the three million organic compounds known are odours). A pheromone must reach, in an appropriate concentration of the order of 10^{-10} gram per millilitre an olfactory surface to stimulate olfactory cells. This can only be achieved by a small proportion of the known organic compounds, i.e., those with molecular weights not greater than 300-400 and which normally do not have more than a single polar group, e.g., hydroxy (OH), carboxy (COOH), amino group (NH_2) etc. Presumably, it is the polar groups that account for an odour's distinctness.

As to the nonvolatile compounds (proteins, nucleic acids, carbohydrates), these are believed to be perceived by another olfactory organ (Jacobson's organ), which is quite small in man.

The search for particular compounds in an animal's secretions seems to be of no absolute importance since the problem of analysing pheromones, of "olfactory images", is rather similar to analysing a visual image.

Thus, the chemical composition of a secretion appears to be species or subspecies-specific. Every organism is characterised by a unique odour and its individuality is accounted for by one specific gland's secretion, e.g., the inguinal gland in the rabbit or the tarsal gland in the black-tailed deer. The gland's secretion is an animal's visiting card. It has been demonstrated experimentally that the pheromone memory in the house mouse is strong enough to retain information about dozens of members of its own species. The following interesting fact has been discovered. If some animals are related they may carry a "family" pheromone which ensures recognition of family members. This is illustrated by the scent-marking act in a great-gerbil colony during which young animals pass occasionally under the belly of the dominant individual to lubricate themselves with his ventral gland's secretion in order to

acquire the same familial odour.

It has been noted that a trap into which a wolf or a fox has been caught is avoided long afterwards by other animals. The reason is that captives leave a warning scent-mark saying "danger". This danger pheromone has also been recorded among rodents and some deer.

Currently, research attention has been focused on a possible relationship between an animal's scent and its social status, but the respective pheromones have not yet been discovered. Interestingly, the weight of specific glands in wild rabbits is strictly correlated to social rank, the higher the hierarchical status of a rabbit, the larger and more active its glands. Can an individual substance induce some definite behaviour? Apparently, it is very easy to isolate a substance from the available set of species-indentifying compounds (acid, base, or neutral) which can elicit a definite behavioral response. However, the data we have obtained at IEAME have revealed that animals do not respond behaviorally to a single chemical, rather it is a definite set of compounds that is informative.

Story of Soviet experiments

Knowledge of the qualitative and quantitative composition of the volatile components in mammalian secretions provided a basis for further research into chemical communication in order to elucidate the properties of those chemicals which convey constant or variable information about an animal.

In order to reveal significant differences in the chemical composition between single-type and different-type glands belonging to individuals of the same or different species, the same analysis techniques should be used. Strangely, this rule is not always observed. We have investigated the overall composition of the major secretion components (in natural concentrations, i.e., without accumulation) of the specific and nonspecific skin-glands in 30 mammalian species. We employed thin-layer tool for detecting the overall compositional differences when making comparative studies of complex chemical mixtures. Members of five orders were used as subjects, these being: Insectivora (desman), Lahomorpha (blue hare, Cape hare), Rodentia (beaver, water vole, great gerbil, Mongolian gerbil), Carnivora (American mink, sable, glutton, otter), and Artiodactyla (wild boar, axis deer, red deer, manchurian wappiti, roe deer, elk, saiga, rein-deer, Thompson's gazelle, Grant's gazelle, impala, Buffon's kob antelope, canna, goitred gazelle, Mongolian gazelle, Pamir argali). The skin-gland secretions in different mammalian species were found to contain carbohydrates and numerous monofunctional and polyfunctional compounds. Each species (and occasionally, subspecies) is characterised by a specific set of component groups in the skin-gland secretions. Two substances common to all the species in our study are apparently cholesterol and monoesters, their concentrations in relation to other substance depending on the species. It follows that the overall chemical composition alone is a marker of a mammalian species even in the absence of data on the individual components of skin-gland secretions.

A study of the anal-gland secretion components that characterise/mark Mustelidae species was performed using gas chromatography. In contrast to thin-layer chromatography, this technique reveals the individual's composition of a complex, mixture's volatile components. By using individual component analysis, comparative studies of the mixtures made using gas chromatography provide reliable indices of the qualitative and quantitative similarities in composition. We analysed the individual composition of the vapours over anal-gland secretions for the following eight Mustelids: American mink, European mink, sable, weasel, European polecat, vormela peregusna, badger, and honey-badger.

In some mammalian species, the presence or intense activity of certain skin-glands serves as a sex marker. Thus the midventral gland in the great gerbil is well developed in males and poorly developed in females, occasionally not being present at all. If females are injected with the male sex-hormone, testosterone, their midventral glands greatly increase in size and they begin to secrete like males. Interestingly, the overall composition of the midventral gland secretion in females is identical to that in males as was demonstrated by thin-layer chromatography.

An analysis of the volatile components in the secretion of the desman caudal-gland has revealed odours with an agreeable perfume The chemicals responsible for this perfume are ketones, which account for a considerable portion of these secretions. On the basis of data we have obtained we can suggest a simple technique to determine the sex of a desman. The six ketones of the caudal-gland can be assayed using an S-index to total their quantitative differences. For females, S has been found to be within the range of 65-70, and for males S 1, it has proved possible to determine sex by caudal-gland secretion even when the secretion has been stored under normal conditions in a sealed vessel for over three years.

The scent of the caudal-gland secretions from a sex-mature and an immature desman individual can be easily distinguished by the human nose. The musk scent so characteristic of mature males and females is absent in sex-immature animals and this agrees with the evidence of comparative chromatography. Immature desman secretions contain none of the compounds that have the characteristic musk scent that man can detect so readily. This indicates that their presence in a desman's caudal-gland secretion is a marker of its sexual maturity. Similar results have been obtained for the midventral-gland secretion of a great gerbil.

Studies of the pheromone that can elicit aggressive behaviour in dominant house mouse males are very important. The urine of a strange house mouse male was applied to a subordinate conspecific male familiar to the community's dominant male. The act invariably elicited a highly-aggressive response on the part of the dominant male. The aggressive response was likewise induced, though to a lesser extent, when the bases isolated from the urine, or a mixture of only two of them (diethylamine and dimethylamine) were used. The addition to the latter of a mixture of synthetic aliphatic amines - triethylamine, isobutylamine, trebutylamine (0.1 per cent aqueous solution of each compound)—augmented the aggressive behaviour. It is noteworthy that separate treatment with each of the above substances brought on no aggressive behaviour What can be inferred from the above experiments? Firstly, the isolated pheromone for house mouse aggressive behaviour has a complex structure that includes several compounds. A theoretical analysis reveals that an aggressive reponse is induced by a mixture containing at least three olfactory cues signifying species ("conspecific"), sex ("male"), individual ("un-familiar").

Our follow-up experiments with house mice demonstrated that recognition of conspecifics requires the presence of three larger groups of substances: acids, bases and neutral compounds. Separately and in pairs, these component groups, fail to ensure individual conspecific identification. This is however achieved when one of the acids and one of the bases is used in combination with a neutral urine compo-

No monkey business, this! With greater knowledge of chemical communication, modern man is getting a wiser and a different insight into the animal kingdom

Bovine bliss! A command of the language of odours will be a valuable tool in reducing aggressiveness in animal groups such as the one shown at right

nent. The conclusion is supported experimentally: house mouse males demonstrated conspecific recognition for an aqueous mixture of isobutylamine, acetic acid, and neutral urine components.

In a series of Norway rat experiments (the same principle of conspecific recognition by a known set of excreted odoriferous substances was tested), our object was to find out whether the species-encoding principle applys to other rodents. We have found that conspecific cues in Norway rats are transmitted via both neutral compounds and mixtures of acids and bases. Separately neither acids nor bases communicate the necessary information. At least two of the mixtures under study, propionic acid-butylamine and acetic acid-butylamine, have been found to serve as conspecific markers. In addition (pairs of bases such as isobutylamine and diethylamine, in combination with acetic, propionic, or isovaleric acids, have proved to be semiologically-irrelevant with respect to species identification. Thus, apparently the simplest (two-component) species marker mixture was the first one we obtained experimentally.

Let us ask now what happens if at least one of the components of the chemical communication system is disturbed. For instance, suppose the chemoreceptor function is temporarily handicapped. If pregnant female mice are injected intranasally with zinc sulphate to deprive them temporarily of their sense of smell, mothers devour their new-born young, or at least, neglect them. Interestingly, the experimental animals proved unable to construct normal-shaped nests. This shows what chemical disturbances of the chemical communication system can lead to.

Practical applications

What are practical applications of all these findings? Is the research in this field really necessary?

The distinguished Soviet physicist P. Kapitsa once said that no scientific knowledge can remain unapplied, in one way or another it will find application and yield practical results, even though it is hard to foresee when this will occur and how.

The studies of insect pheromones in the 1960s not only yielded some interesting results, they also paved the way for pheromone research in mammals. In recent years, interests in chemical communication between animals has increased for several reasons. One of them is that the intensive pesticide impact on the environment undertaken for pest control, has brought about unexpected complications. New specific pesticide-free methods of plant protection are needed. These can be based on chemical cues for these techniques make it possible to selectively manage pest behaviour without affecting their metabolisms directly.

The nature of animal interaction, for example, stress, neighbourly co-existence, permanent enmity, etc., has been shown to determine the fate of offspring and their numbers. The knowledge of the scent code which is the chemical language of animals will not only make it possible to increase and maintain numbers of useful species but

A good command of the odour language is required to control rats, the ancient plague of mankind

also to reduce pest numbers

Considerable advances have been made in this field Pheromones have been synthesised for the scarce bordered straw moth the plum fruit moth, the coding moth and the Oriental peach moth Successful pest control is ensured by the use of pheromone baited traps into which insects are immediately enticed, or can be achieved by the distribution of pheromones to disorientate the pests

That the use of pheromones has advantages over the other means of control specifically insecticides, is beyond doubt

—S R NAYAK

—E HANUMANTHA RAO

While thousands of tons of pesticides are distributed over huge cultivated areas volatile pheromone compounds are not poisonous and not detrimental to the environment In addition, they are needed for plant treatment only in small quantities and low concentrations

A good command of the odour language is required to control rodents, the ancient plague of mankind Norway rats, house mice, voles, gerbils, and many other species, are known to destroy and damage large amounts of foodstuffs. They are reservoirs of diseases, hazardous to man and his livestock and destroy his buildings and various other materials Despite incessant control rat numbers are currently estimated at about seven billion Their fecundity is enormous in a single year one couple is capable given favourable conditions, of producing up to 15 thousand offspring The use of natural chemical cues is one of the principally new and promising trends in controlling this perfectly-adapted synanthropous animal

Pheromones can also play an important role in fur hunting, which requires animals to concentrate at a pre-set site For years, hunters have preferred artificial baits and the use of pheromones could be very effective

The industrialisation of farming has brought with it a number of problems associated with the management of animals physiological states and behaviour A command of the language of odours will be a valuable tool in helping to reduce aggressiveness in animal groups to accelerate sex maturity and synchronise estrus and establish its dates

The language of odours calls for further studies since animal behaviour is very complex researchers face numerous problems It appears that we need a different and wiser insight into the animal kingdom Modern man the *Homo sapiens* has become *industrial man Homo faber* and is divorced from nature He looks down on Nature s other creatures through the magnifying glass of his knowledge but is this approach justified?

We must be mistaken for animals should not be judged from a human standpoint In their world, more ancient than the world of man, animals are perfect creatures with their own range of perceptions and perhaps

feelings, which are beyond human beings or which humans lost long ago. Animals live in a world of odours: and odours constitute their language.

We should work to understand this language to gain from animals' evolution-old experience all that may be of use to us. □

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The gnat sings and the bee dances

Vasant S. Sahasrabuddhe

"WE could learn modesty from the cat, honesty from the ant, chastity from the dove and good manners from the cock," says the Babylonian Talmud. Implicit in it is the belief that but for the "gulf of language" separating them, men and beasts are alike. Indeed, King Solomon of Babylon was said to possess a magical ring which could bridge this gulf This wonderful gem told the wearer all he desired to know including the language of birds and bees...

However, fables apart, we have yet to decipher the vowels and consonants of "animal language". But we *do* know their ways of communication methods, because we are familiar with their signals and can recognise their effects. With techniques such as recording, spectral analysis and multiple reproducing scientists have obtained some insight into the fascinating problem of how animals communicate.

Vocal signals emitted by animals are as widespread and varied as the senders themselves. Some are role-calls signals, others sound the alarm, a third type announces that a nesting area has been taken, some recognise and attract their sexual partners. For example, when a predator is perched in a tree, the "mobbing" of small birds is a definite warning: "Leave our property at once." Other expressions are no doubt carriers of meanings such as "Come here," "Help me to build a nest" or even, "Fly straight ahead for 200 metres, about 30 degrees to the left of sun to find a blooming clover." Analysis of these signals, deciphering their "meaning" is the essence of our investigation.

Though sound signals are superior to many other type of signal, some creatures, especially those like insects which lack vocal organs, resort to some auxiliary means to express their emotions. Beak clicking, for instance, is very common. The typical sound of Hudson Owl is a loud clicking of the beak. The sounds emitted by storks are the result of the same technique. Some birds beat their wings. The woodpecker delights his lady by beating his wings on dry tree trunks, with a speed of

forty beats a minute Many birds emit sounds when moving The cry we hear of the snipe is due to the vibration of the retrices, special quills on its tail The fearful "singing" of the gnat is not produced through its mouth, but by the motion of its wings, which vibrate between 500 and 600 times a minute The honey-bee beats its wings 440 times a second while the ordinary housefly vibrates its wings 220 times a second In case of grasshoppers, crickets and cicadas, length and rhythm play a major role Many ants and crabs beat messages on the ground with their posterior ends or limbs Among fish, some species rub their branchial plates together to make sounds The carp grits its pharyngeal teeth The percoids make sounds with their swimming bladders by contracting special muscles that make the walls of the bladder vibrate These optical signals consist of body movements as well as colour changes and a time patterns Consider for instance the chameleon This lizard s com munication by colour" can be identified only after extensive recording of colour change and a study of the situations is which they occur

Then we have communication with the help of self-luminescence, a common practice amongst insects which include springtails, lantern flies, click beatles, the larvae of certain flies and, of course fire-flies and their larvae the glow worms We certainly know that this language of luminescence helps the male to find a mate

The flash signals are species specific There is no chance either, for confusion or mistakes as it would spell death to the male To avoid this, a highly sophisticated system of signalling has been developed Males flying above send rhythmic short flashes at regular intervals After a decorous interval the female on the ground flashes a short response The male glows again with a turn towards his would be companion The female responds once more with a flash and the exchange of signals is repeated usually five to ten times The male then dives straight towards the female and the two mate Human collectors, aware of this system, often do their collecting at night and send out the female s own message by artificial flash light

Insects are also able to recognise ultra violet as a separate colour in most flower blossoms Many birds sing in the ultrasonic sound range which is inaudible to human ears Some nocturnal animals make wide use of ultrasounds or echoes as much as other sound signals The technique is mainly used to locate objects, especially food Among the nocturnal creatures the guacharo and the bat are the two classic examples using ultrasonic sound The guacharo emits short sounds in a frequency range of 7000 cycles per second and it is perceivable by human ears Bats locate food with sounds of low frequency and intensity of upto 150,000 cycles a second Many bats send their signals not by mouth but through their nostrils Perhaps the most baffling problem about bats is how they "discriminate" between one another s sounds Despite loud "noises" or "jamming", they detect their target perfectly Man's inability to directly sense these ' ultra sounds is indeed a hindrance in the study of communication Research is on the march and now it is possible to convert inaudible sonar signals into audible clicks

Communication among the dolphins is even more perplexing Experiments show that dolphins actively inform one another about their surroundings or establish communication between each other as and when they wish If this is true, then the signal communication system of dolphins is much closer to human speech than that of any other animal Colour form movement and time pattern are the component parts of optical signals, while frequency interval, wave-length, modulation purity of tone etc are the characteristics of sound signals The question arises How do animals detect particular signals of his own species and how do animals know exactly what a signal means? Do they learn the meaning of each element before they understand the whole? Or are these abilities inborn?

Experiments show that the ability to sing is an inborn reaction but the bird must hear at least once before the voice of its own kind A chaffinch raised in isolation will not emit the typical chaffinch song When exposed to various songs during the learning period it will select and learn the proper chaffinch song Birds usually know innately when to sing but not what Secondly, the meaning of each vocalisation its role as a signal is passed along for the most part genetically only extremely intelligent animals ravens parrots and jackdaws for example are capable of using learned traits appropriately as signals Parrots whose vocal cords are the most similar to those of human beings can be taught to utter words and whole phrases in any language and to use them in keeping with the situation but without self-understanding Hence a pet parrot says Good night before going to bed , even though there is nobody to listen

What a parrot seems to be able to do is far beyond a chimpanzee, that is, talk like a man Latest studies carried out at Max Planck Institute of Psychiatry in Munich on newly born squirrel monkeys *(Saimiri sciureus)* have shown that these animals' whole sound repertoire is inborn They develop all their calls without ever having heard them from others Thus, their learning has equally been programmed genetically All animals are unable to subject their vocal apparatus to the control of their will That which any given species is congenitally able to do and learn is predetermined

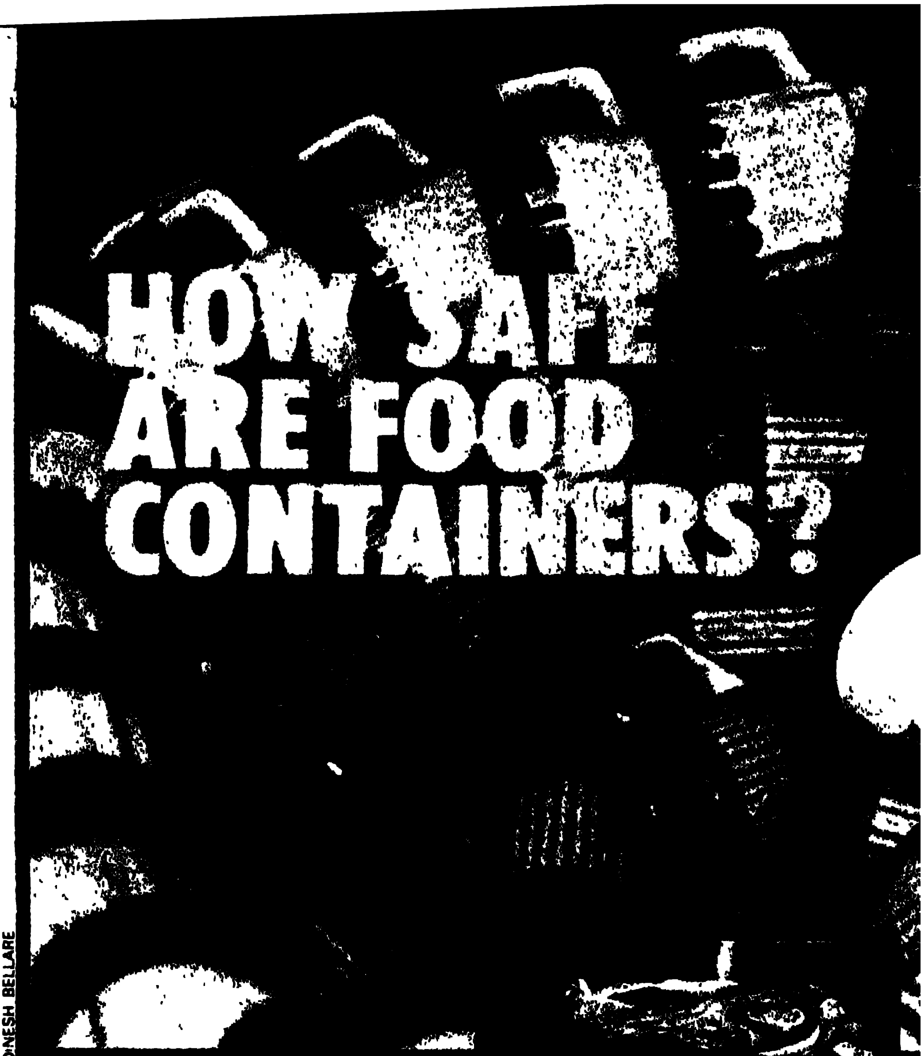
Now, the question remains Can animals really converse? Can they communicate information at their own will? Can they put a name to something? Can animals lie to one another? These are the characteristics of a highly developed communication system, and man boasts that they belong only to his own form of language The fact is, all these characteristics can be found among lower animals as well

Each black bird composes its own song, each has a particular song with which it attracts its mate The Asiatic shama thrush and the raven have individual specific vocalisation bees communicate distance and direction of food sources to others in the hive by a so called bee dance and thrushes ravens and black birds upon finding an appetising titbit some time emit a warning cry to send their rivals under cover so as to enjoy alone their find Thus bees symbolise crows converse black birds lie parrots distinguish

As said at the beginning our aim is not to communicate *with* animals but to understand *how* they communicate among themselves Much of the modern research in communication systems centres on this problem Much can be learnt from various members of the animal kingdom and new and enlightening surprises still await, if physicists and engineers organise appropriate experiments □

Prof Vasant Sahasrabuddhe taught civil engg subjects at polytechnics He has written over dozen science books

HOW SAFE ARE FOOD CONTAINERS?



DINESH BELLARE

POP into any shop or a departmental store, catering to kitchen needs and you will encounter a dazzling array of utensils. You might be in a dilemma when making your pick and return home empty handed, disappointed. But that need not be the case lady, arm yourself with the latest info on these pots and pans of glass and brass. No more nagging thoughts on the safety of different materials will plague you.

Since the dawn of civilisation, different types of materials-- metals, glass, wood, ceramics--have been used for storing, preserving, distributing, cooking and serving various forms of food. They may be grains, sugar, pickles, condiments, dairy products, meat or fish. Advances in technology have resulted in newer materials, like plastics, invading our hearth. And, hence the housewife has to select the right type of container or utensil or kitchenware, keeping in mind her budget and the durability and safety of the container.

Metals have been in use since time immemorial for making different types of utensils, boxes, plates, ornaments and weapons. Gold, one of the first metals to have been discovered, was popular with kings and emperors who gave it great importance as a status symbol. They often had gold utensils for their daily use. Gold is an attractive selection for a container, because of its lustre and stability to environmental conditions like heat, cold, wind and humidity. However, because it is a rare, expensive metal, its use is limited to making ornaments, to a few medical uses and as an international monetary unit. Copper has been used by man since the stone age. For centuries, copper was the only metal used for making utensils, vessels and kitchenware such as plates, glasses, spoons and serving dishes. Later, the alloys of copper, namely bronze and brass which are harder and more durable than copper were developed. Man then started using these alloys to fashion containers and articles for household use. Pure copper is not poisonous, but its alloys with other metals, may have toxic effects especially if consumed in the fine powdery state. All copper salts have toxic effects to varying degrees.

Ghee and butter are sometimes stored in brass or copper vessels lined on the inside with tin. If the tin lining *(kalai)* contains lead as an impurity, it forms a poisonous salt, the oleate of lead which can lead to chronic lead poisoning (plumbism). (See *Science Today*, June, 1983, page 43). Plumbism usually affects the poor, since their food is often cooked in tinned utensils.

Zinc is another metal from which containers are made for storing water or milk. This is a dangerous practise which has led to chronic zinc poisoning. Acute poisoning may also occur after consuming food cooked in zinc-lined vessels, such as galvanised iron vessels. This occurs because zinc is soluble in the weak acids of foods. And if consumed, gives rise to symptoms such as dizziness, colic, diarrhoea, tightness in the throat and convulsions.

S.N. KULKARNI

Silver and copper have been associated not only with ornament-making but are also considered as auspicious metals, required for religious ceremonies. Silver has been used in the manufacture of utensils for safe storage and serving of food. Silver utensils are safe to use and only the salt silver nitrate is of toxicological significance. Tin containers and utensils are still used by the food industry for storing dry food and do not create any toxic problems. Food prepared in tin utensils have a "tinny" taste due to small amounts of iron dissolved from the iron base of the can. Traces of iron and tin are harmless, though the presence of lead as an impurity in tin cannot be disregarded.

Food cooked in utensils made of aluminium, enamel, glass or stainless steel are not injurious to health. When water or food with a low acid content is boiled in an aluminium utensil, the aluminium utensil darkens due to the formation of a greyish-black metallic oxide, leached either from the aluminium metal or from the iron salts present in water or food. Subsequently, when acidic foods are cooked in the same vessel, the oxides are dissolved by the acid present and the utensil regains its shine.

The choice is wide but let it be wise

once again Aluminium utensils are not harmful.

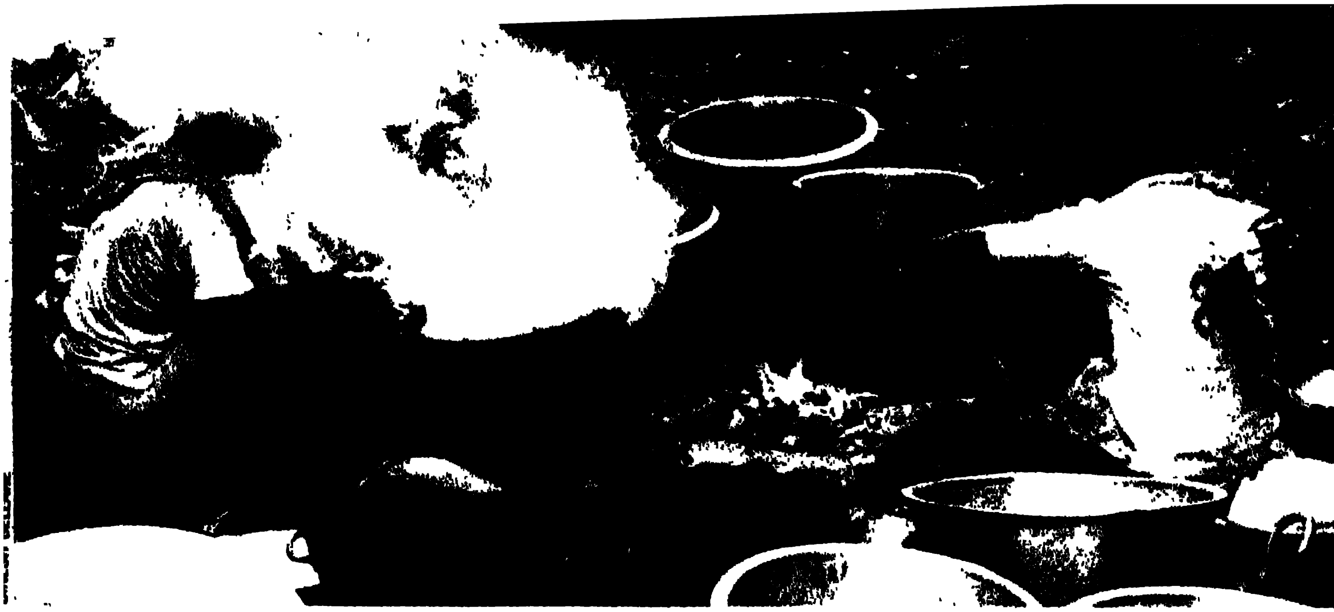
Containers made of ordinary clay, china clay, enamel and glass also form a part of our utility kitchenware. Housewives favour them for serving eatables and water. There are varieties of glassware which can withstand cooking heat and hence can be used for cooking food too Utensils made of silicates are easily washable and have a clean appearance. Besides, the food, cooked or served in these utensils, is safe They are dangerous only if one gets cut by their fragments or when the latter are ingested However, their use is restricted because of their fragility and the recurring expenditure for replacements. In many families, stainless steel utensils have replaced glassware because of economic reasons Food cooked and served in stainless steel ware is safe and the utensils have a clean look and are easy to maintain.

Plastics make inroads

The introduction of plastics has revolutionised our concepts of container facilities. Plastic items have become an essential part of our daily life. Polythene bags, utensils, kitchenware, buckets, cups, combs, baskets, toys, brushes, and a variety of useful household items and yarn are made from plastics. They are a boon to the housewife who can now discard rusty-looking tin containers for attractive coloured, clean plastic ones. Plastic by virtue of its durability, cleanliness, attractive appearance and safety has replaced many other materials from which containers were made.

Currently, attention is focused on the safety of using plastics not because there is any evidence of danger in the daily use of the many items, but we are still unfamiliar with many of the ingredients that go into plastic production. The resin bases of some plastics are made by polymerisation of a monomer or the co-polymerisation of two monomers or from natural polymers. Toxicologists are concerned with the leaching of free monomers, the extractable component. The danger of extractable monomers causing harm, is especially of concern with regard to plastics intended for the manufacture of containers or for accessories for medical preparations, such as blood, saline and glucosaline storage and for fabricating infusion sets, etc. It is for these reasons that rigid toxicity tests are laid down in pharmacopoeas and by regulatory bodies for evaluating the suitability of plastics intended for fabrication of containers and accessories for medical preparations. Also the safety of catalysts, emulsifiers, and antioxidants combined with the resin base are assessed.

The safety of plastics used for packaging, distributing and storing foods is difficult to assess. When plastics come in contact with certain types of food, some of their components may leach out into the food. These plastic-components, contaminate the food. Testing of this aspect is cumbersome. It is done by using solvents with which the particular plastic comes in contact, such as sodium chloride, acetic acid, sodium bicarbonate, vegetable oils and alcohol. The food samples are then quantitatively analysed.

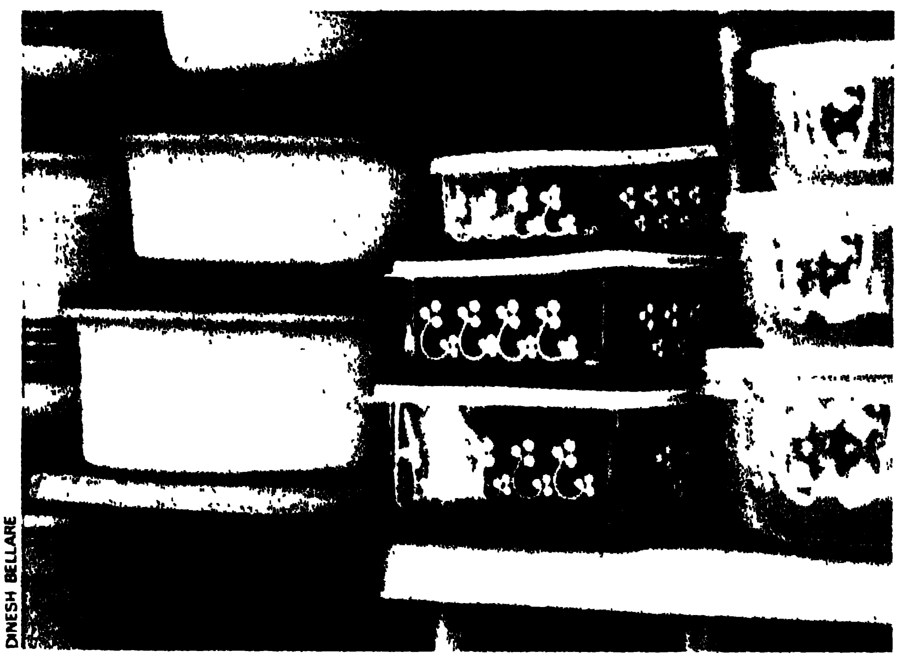


Tinning of utensils

Plastic containers in which dry, non-oily food like sugar, flour and pulses, etc, are stored are not generally contaminated by their components except if the plastics are abraded or broken.

Plastics also contain catalysts, plasticisers, emulsifiers and antioxidants which are combined with the resin base for achieving the finished product. In many countries the use of additives in food grade plastics is controlled by legislations. In India, the relevant law under the Prevention of Food Adulteration Act No. 37, 1954 with amendments upto 1968 covers items such as utensils, packaging materials and also plastics (Section 21, 1954 Act). It recommends that plastics must conform to the national specifications of either the USA, UK, France or West Germany.

A type of kitchenware which is popular abroad and among affluent housewives in India today, are non-stick utensils sold under different brand names—*Nirlep, Trupti, Westmark,* etc. These utensils are coated with a thermoplastic resin such as teflon (a polymer of tetrafluoroethylene). Many utensils like frying pans, flat griddles, saucepans, toasters, and *tawas* are coated with teflon (polytetrafluoroethylene) as a non-stick coating, as it is more thermostable than most plastics. Teflon coated kitchenware is not dangerous while cooking, as the maximum temperature for cooking different types of foods in these utensils ranges between 130 to 200°C, well below the decomposition temperature of teflon. Only above 250°C, teflon slowly starts decomposing to release pyrolysis fumes which are toxic. But these high temperatures are attained in industries and not during domestic cooking, even if prolonged. Precautions should be taken not to overheat the utensils to temperatures exceeding 200°C (400°F) and not to allow empty utensils to remain on the fire for a long time. The coatings are prone to damage if scrubbed with hard materials and harsh detergents during cleaning or if sharp instruments are used for turning and lifting. Spatulas with smooth finished edges, such as wooden spatulas can be used for stirring or turning and lifting the food items. The utensils should be cleaned with cloth or a sponge dipped in hot soapy water to prevent damage to the coating.



DINESH BELLARE

Many types of materials ranging from metals such as gold, copper, tin, aluminium, zinc to glass, enamel, china and plastic have all been used at some time or the other as utensils or containers in our homes. But, the selection of the right type of utensil or container for household purposes will depend on what it is to be used for. Utensils made of stainless steel, aluminium, glass, china and enamel are safe for use as cooking utensils, for storing potable water and for serving food and beverages. Utensils made of brass, copper and bronze should be limited to cooking non-acid foods and as containers for drinking water. Plastic utensils can be safely used for storing and serving all kinds of foods, beverages and water. Ordinary clay pots are used for cooking food in villages. They are safe but easily breakable and so more durable materials such as aluminium and stainless steel are fast replacing them.

V. Ramakrishna Rao

Dr. Ramakrishna Rao, an Assistant Director, is with the Department of Toxicology, Haffkine Institute, Parel, Bombay.

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Resources for tomorrow

THE POWERFUL METAL

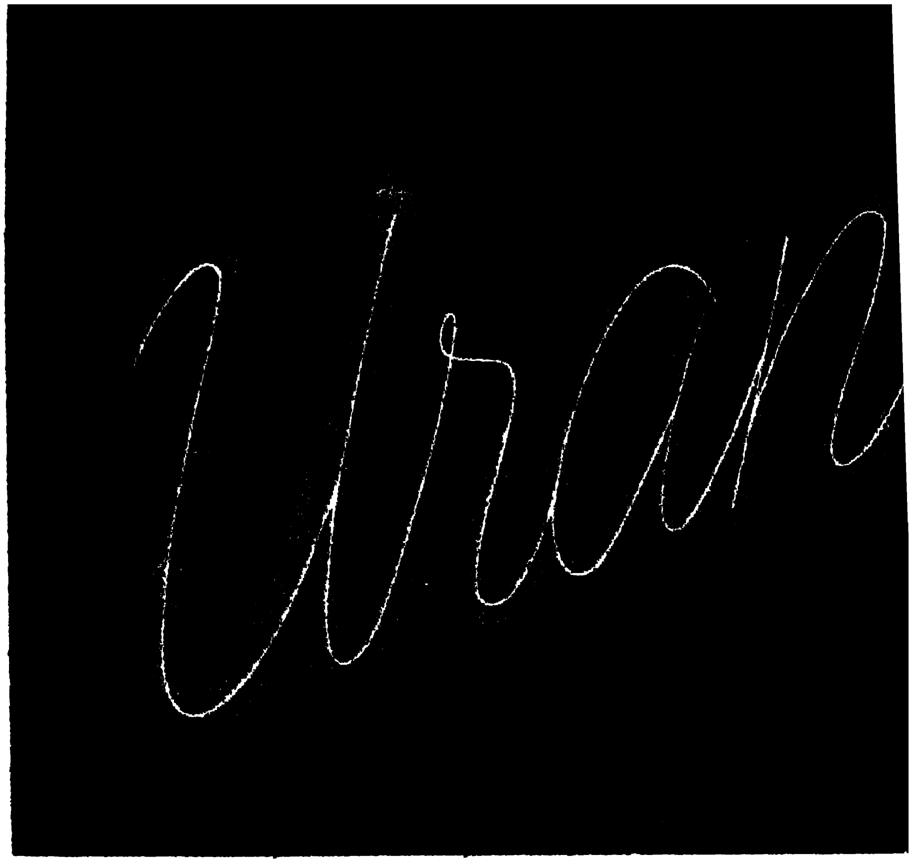
T. K. S. Murthy

URANIUM occupied the *last* place in the periodic table until the late 1930's and was relatively unknown with hardly any industrial or economic importance. It had the highest atomic weight (238) and atomic number (92), then known. Nohody could have even imagined at the time, that uranium was to be an important source of energy and a material for deadly explosives thus, assuming strategic importance precisely due to its heavy nucleus.

Uranium was discovered in 1789 by Klaproth while studying the mineral pitchblende. The element derived its name from the planet Uranus, then newly discovered. Almost half a century elapsed before the metal could be extracted from its ore by Peligot, the founder of the chemistry of uranium.

For a long time uranium and its compounds were to remain scientific curiosities without any industrial use. Later, the characteristic bright greenish-yellow colour of uranium compounds led to their use as colouring matter in glass and porcelain.

It was also known that some uranium compounds glowed with a striking greenish yellow fluorescence when exposed to sunlight, which persisted for a while even after the compound was removed from sunlight. It was while studying this property that Becquerel, a French scientist discovered accidentally, the phenomenon of radioactivity (radioactivity is the manifestation of the instability of an atomic nucleus. An unstable nucleus has a tendency to attain stability by disintegrating into another nucleus—also called nuclear transmutation—emitting simultaneously radiations of the type alpha, beta and gamma).



Beta uranotile

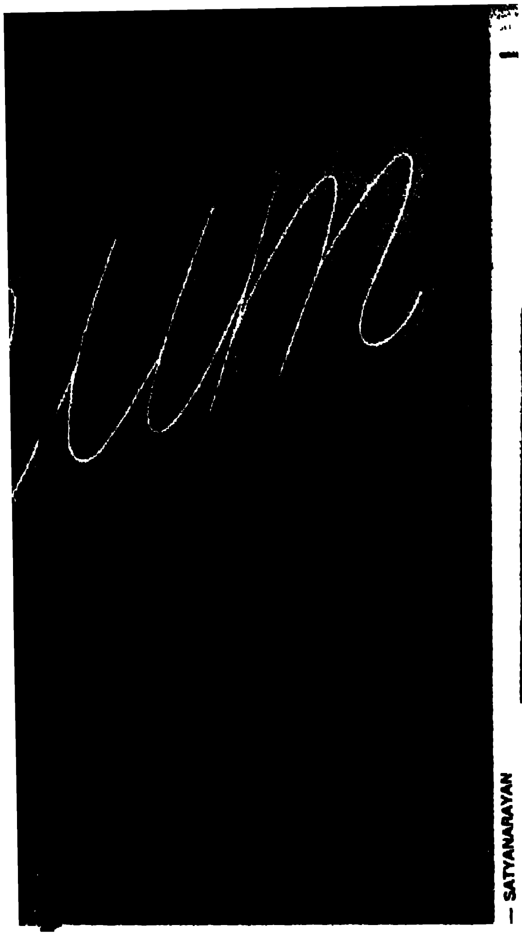
Chalcolite

It was soon established that the uranium nucleus undergoes successive nuclear transmutations to end up finally as the stable element lead. However, a mass of uranium takes billions of years for breaking up and getting transmuted to other elements, in contrast to some other nuclei which decay in a matter of seconds or even less.

The observation by Marie and Pierre Curie that uranium bearing minerals showed much greater levels of radioactivity than equivalent amounts of purified uranium led to the important discovery, by Marie Curie, of a new element radium, in those minerals. This was to be followed by the discovery of a few more radioactive elements in the same minerals.

An understanding of natural radioactivity was quickly followed by artificial radioactivity. This phenomenon was based on rendering the normally stable nucleus unstable by bombarding it with small positively charged particles like alpha particles and protons, and even uncharged particles like neutrons.

Neutron was also discovered around this time(1932) and the neutrons



— SATYANARAYAN

bearing no electric charge proved to be more successful in bringing about nuclear transformations than the alpha particles.

Nuclear fission

Otto Hahn and Lise Meitner of the Kaiser Wilhelm Institute in Germany were bombarding a number of metals with neutrons in the late 1930's. When uranium was the target they had great difficulty in interpreting their results by the known facts. A big surprise awaited the scientific world when at last an explanation came through. They had succeeded, quite unexpectedly, in breaking the uranium nucleus into two almost equal parts. This phenomenon was called *nuclear fission* by Lise Meitner and Otto Frisch.

The fission was accompanied by the liberation of considerable energy and also more neutrons. The neutrons liberated in turn could split more nuclei, setting up a chain reaction. It soon became obvious that a controlled chain reaction could provide a steady supply of energy (a nuclear energy machine or a power reactor), whereas an uncontrolled chain reaction would lead to explosion and destruction (nuclear explosives).

Kasolite

Alpha uranotile

When uranium is exposed to neutrons, in addition to fission a nuclear reaction leading to the formation of new elements such as neptunium and plutonium can also occur. Further nuclear reactions using these as targets led to a number of new man-made elements, namely the transuranic elements. Thus, uranium is unique in being responsible for a number of epoch-making discoveries like radioactivity, radium, nuclear fission and transuranic elements.

Uranium in nature

Uranium, surprisingly, is more abundant in Earth's crust than many familiar elements, like gold, silver, mercury and even tin. Like iron, it exists in nature as an oxide occurring in various mineral combinations with silicon, nickel, cobalt, vanadium and other elements. It is present in varying concentration in most rocks and soils. Sea water carries uranium, though in very low concentration—three parts of uranium in a billion parts of water. Some uranium minerals are characterised by bright colours, chalcolite kasolite, alpha uranotile being a few Before the dawn of nuclear era rich uranium ore deposits of Belgian Congo (Zaire), Joschimstahl (Poland) and Blind River (Canada) were mined only for the sake of radium. The situation changed dramatically after the discovery of nuclear fission. Prospecting for uranium minerals was intensified the world over and large quantities of low-grade ore are found in many countries. Spectacular progress has been made in the technology of mining and winning uranium in the past three decades. Presently, any ore bearing 1.0 kg or more of uranium per ton is considered economic.

Exploring for uranium minerals

The search for uranium involves many disciplines of science and engineering. The areas favourable for uranium existence, based on geological factors, are first identified by the geologists. Further narrowing down of prospective areas is done with air borne radiation counters

After the promising areas are thus marked out prospectors go there on foot for a closer examination of rocks, soil and water. If the findings are encouraging further exploration is carried out by drilling to obtain underground core samples for analysis, to determine uranium concentration and distribution.

Mining of uranium ore is essentially similar to the mining of any nonradioactive minerals like those of copper and zinc. However, due to the radioactivity associated with uranium and the release of minute amounts of radioactive gases like radon in the mine, special precautions are needed for providing powerful ventilation in the mine. If necessary, respirators are used by the underground mine workers.

From ore to 'yellow cake'

Typically 1,000 kg of ore must be mined to obtain 1 kg of uranium oxide

Uranium oxide undergoes complex metallurgical operations before it is ready to be used as a nuclear fuel

(U_3O_8). It becomes necessary, therefore, to separate a small amount of uranium from a large amount of waste materials. A series of elegant chemical-processing steps are employed to achieve this, which can only be outlined here.

In the uranium mill the process begins with crushing and grinding the ore to a fine powder. It is then mixed with water and made into a slurry. Sulphuric acid and an oxidant like manganese dioxide are then added. The conditions in this process called 'leaching' are so adjusted that the uranium minerals dissolve preferentially along with a very small amount of the impurities present. The uranium bearing solution is then separated from the bulk of the solid by filtration.

Because of the small fraction of uranium oxide removed from each ton of ore, the uranium mill produces far more waste than the desired product. The solid waste contains some of the radioactive products like radium, which were present originally in the ore. The waste is chemically treated to immobilise the radioactive and other impurities and is pumped to specially prepared huge settling lakes. The solid settles down. Only water carrying permissible level of impurities is allowed to enter the natural water course.

One of the special processes for concentrating and purifying uranium from leach solutions is the 'Ion-Exchange Process'. Here the solution is passed through a series of columns packed with small beads of a special ion-exchange resin. Uranium is selectively retained on the resin while most of the impurities pass out. When the bed is saturated with uranium, that is when it cannot take up any more uranium, the solution flow is cut off and a solution of common salt in a small amount is passed through. Uranium which is now displaced from the resin, is in a somewhat purified and concentrated form in the salt solution. By adding ammonia or magnesium oxide uranium is precipitated as a yellow solid which is recovered by filtration and dried. This is called 'Yellow cake' and about 70 per cent of it is uranium oxide.

Reactor fuel

The yellow cake produced in the uranium mills is impure. For use in nuclear industry uranium oxide has to be of a high degree of purity. Some impurities like boron and cadmium should be brought down to less than one part in a million parts of uranium. This chemical processing and conversion of the uranium into a form suitable for making reactor fuel is carried out in a refinery. A special technique called 'liquid-liquid extraction' or 'solvent extraction' is universally employed for this purpose.

The yellow cake is first dissolved in nitric acid, yielding an impure uranium nitrate. A liquid organic chemical called 'tributyl phosphate' (TBP) is then added to it. TBP is not miscible with the solution, but on intimate mixing it selectively extracts uranium nitrate leaving the impurities in the aqueous (water) solution.

After allowing the two layers (aqueous and organic) to settle, the TBP layer, containing pure uranium nitrate is separated. When this, again, is mixed with water, uranium is transferred to the water layer and the TBP is ready for re-use. Purified uranium in the aqueous solution is precipitated with ammonia to obtain solid ammonium diuranate (ADU). This, on heating in an atmosphere of hydrogen is converted into uranium dioxide (UO_2), which is used as fuel in nuclear power reactors. Uranium dioxide is further processed to obtain the metal for some applications.

Uranium fuel cycle

Uranium oxide undergoes complex matallurgical operations before it is ready to be used as a nuclear fuel. In brief—oxide powder is pressed into cylindrical shapes and 'fired' to obtain high density pellets, about 1 cm. in diameter and 2 cm. long. Each one of the pellets is equivalent to nearly a ton of coal in terms of energy produced. There may be several millions of these in the heart of a nuclear reactor, also called the core.

The pellets are packed and sealed in thin walled tubes made of a special alloy called 'zircaloy'. The tubes are then made into bundles which can be loaded into reactor vessel. These being only mildly radioactive can be handled without special protection.

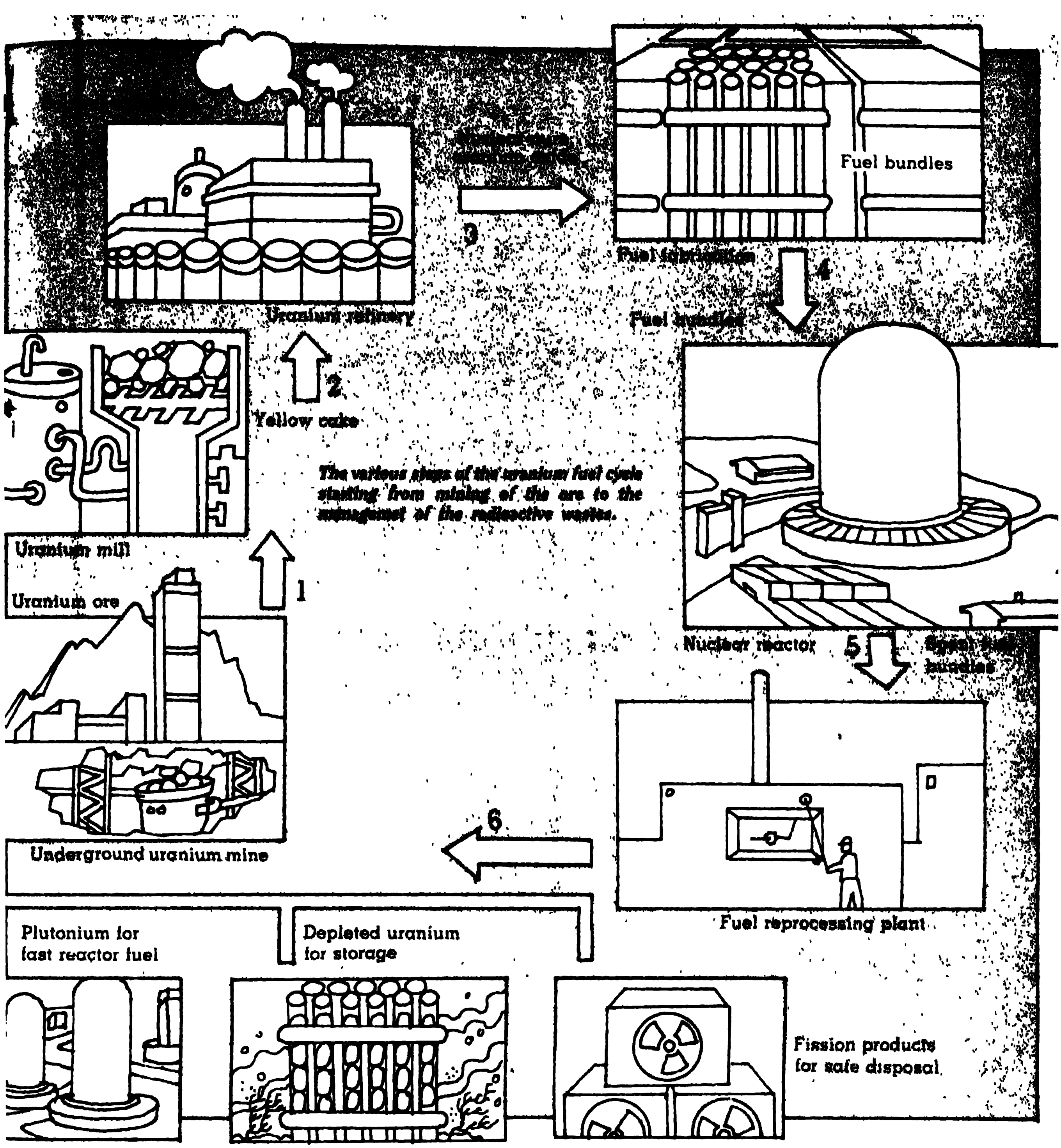
In the reactor the main reaction occurring is the fissioning of uranium nuclei (see box above).

Enriched uranium

NATURAL uranium consists of a mixture of isotopes U^{235} and U^{238}, but the lighter isotope that undergoes fission and liberates energy forms only a small fraction, about .7 per cent of it. The rest, that is nearly 99.3 per cent of it is U^{238}. Some reactors (which use ordinary water as moderator and coolant) are designed to work on fuel with increased U^{235} content, upto 3 to 4 per cent. The process of increasing the concentration of U^{235} to a higher level is called 'isotopic enrichment' or simply 'enrichment'.

Several processes exist for this purpose, gaseous diffusion being the main large scale technique employed. Firstly, the yellow cake (uranium dioxide) is converted to uranium hexafluoride (UF_6) chemically. This compound is then converted into gaseous form and pumped through special porous diaphragms which contain holes about a millionth of a cm. in diameter. Since molecules of the gas bearing the lighter isotope diffuse a little faster than those bearing the heavier one, the gas that passes through is slightly enriched in U^{235}. This process is to be repeated a thousand times before the required level of concentration (3 to 4 per cent) is realised. Enrichment over 95 per cent (required in nuclear explosives) is also possible by a much more elaborate gaseous diffusion process. For fuel fabrication the enriched hexafluoride needs to be reconverted to uranium dioxide.

T.K.S.M.



U[illegible] + neutron (slow) $\xrightarrow{\text{fission}}$ fission products + energy

The neutrons released can sustain the chain reaction provided they are slowed down and this requires the use of a moderator along with the fuel.

There are many reactor designs but the most common fuel-moderator combinations used are

i) natural uranium (fuel) and heavy water (moderator and coolant)

ii) enriched uranium (fuel) and ordinary water (moderator and cooler).

The second important reaction in the reactor is the conversion of U[illegible] to neptunium and plutonium. The by-product plutonium is of special interest as it is a fissionable material and hence can serve as a nuclear fuel.

U[illegible] + neutron ⟶ U[illegible] ⟶ neptunium ⟶ plutonium

After the fuel bundles have spent a specified amount of time in the reactor vessel, they are removed and chemically reprocessed. The aim of this operation called reprocessing of fuel is to

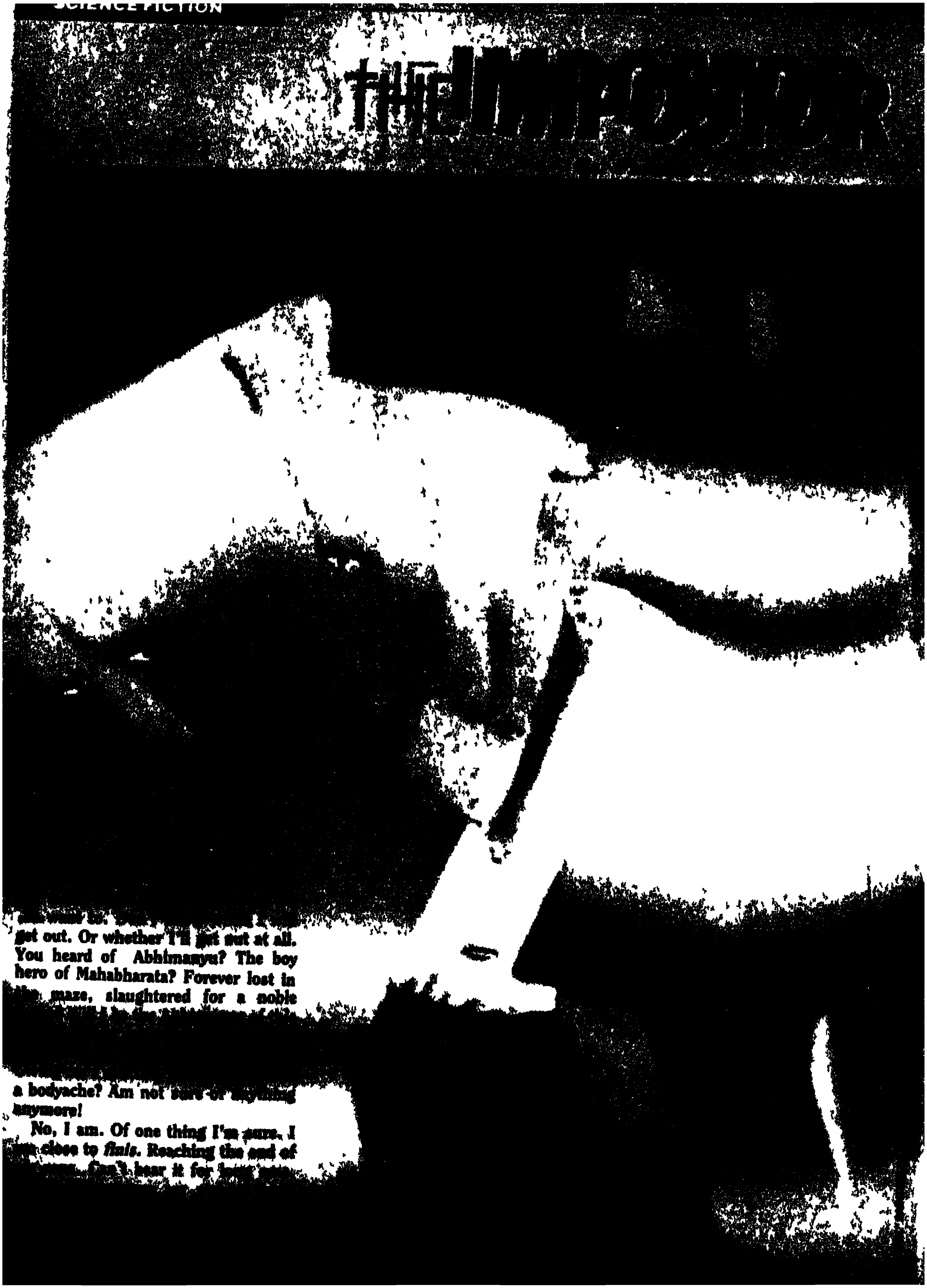
[illegible] recover the plutonium that is produced so that it can be used in advanced type of reactors and nuclear explosives

separate the highly radioactive fission products and prepare them for safe disposal. A build up fission products not only increases the radiation level but also leads to excessive absorption of neutrons resulting in loss of efficiency.

[illegible] recover depleted uranium for storage

Continued on page 54

THE IMPOSTOR



get out. Or whether I'll get out at all. You heard of Abhimanyu? The boy hero of Mahabharata? Forever lost in the maze, slaughtered for a noble

a bodyache? Am not sure of anything anymore!

No, I am. Of one thing I'm sure. I am close to *finis*. Reaching the end of

I'm close to finis... reaching the end of my rope. Can't bear it for long... See if *you* can find a way out

That's the only reason, cross my heart. Otherwise wouldn't let even my breath betray me. No, Sir! Bound as I am by the oath taken under the Official Secrets Act—Military Secret at that. Cor Blimey! it's a razor-edge walk if there was one. That's bloody dangerous. Explosive! No, No. Better keep my trap shut! Mum's the word!

Oh no! Not to worry. Wouldn't do anything rash, like jumping off this cliff here! But it's not easy. This constant impotent thought! This inability to sire a solution! Feel as if my head will crack any minute now. Like an overheated field gun. To hell with the Official Secrets Act. Stuff it up yours! Must blurt it all out. For my sake. For Sadashiv's sake!

What's that? Oh yes! Haven't told you who this bloody chap Sadashiv is. Have I? See what I mean. This is what happens. Can't think straight for a minute. But with you that wouldn't do. For you I should begin at beginning. Dot my i's and cross my t's. Can't leave out even the minutest details. Lest you are as confused as the next chap. Or worse.

Let me introduce myself first. I am Lieutenant Colonel Arvind Jamkhedkar, AMC. That's right. Army Medical Corps. Yes. I am a physician. From the Army.

Sorry? Did you say—? You are right. Normally we medicos don't get to go beyond a Captain or a Major. But I saw action during the Bangladesh War. And Lordy what a piece of action that was! Deployed our surgical unit bloody efficiently. That helped. And also the later stint on deputation at the Medical Wing of NASA. Higher training in military medicine. I took that opportunity to spend some time training under Michael DeBakey in nearby Houston. You got it! The very same Michael DeBakey—the world famous heart transplant surgeon. Even on return I kept up my research in that line, in addition to the routine coughs and colds and cuts and bruises. That's got me half a dozen fairly decent papers in the International Journal of Military Medicine.

What? Oh, don't go old man! You have a right to wonder if I am on a first person singular trip. Vain sort of yakking about myself. But believe me, I've got to fill you in on all these details. It's got its own purpose.

But about that later. Was telling you about how it all began. Still remember that day. Bright as noon. Large as life. Great day. It was Lali's birthday. Lali—Lalita—you know, the better half.

Oh no! You won't! You won't go about calling on her even to confirm what I'm telling you, will you? For she hasn't the foggiest. The army grinds it into us. Got to keep such secrets even from one's near and dear ones.

So it was Lali's birthday. I never forget it. Had taken the day off as usual. We were going to dine out. May be throw in a movie later. And, the shopping, of course. A saree, or a dress. Something like that. I agree the programme's no great shakes. But breaks the monotony of a chap's routine.

Well, we were all ready to charge off when who should call? The Commandant. I was needed back at the garrison. Immediately.

Was Lali hopping mad? I couldn't meet her eyes. White as a sheet she was, but breathing fire, man. Ah Lali! Blast this army life! Well, Lali, too knows the score by now.

I left on the double and presented myself to the Commandant. Saluted him smartly.

Now the Commandant, there's a good man. A first-class soul if there was one.

"Sorry, Doctor," he said. "Sorry to disrupt your programme. But it's none of my doing. Intelligence HQ want you. It's urgent."

For God's sake. What have I to do with intelligence?

Why? Why that smirk? Oh! *Touche!* Well played!

I meant Army Intelligence though. For that matter the Army Intelligence doesn't have much to do with intelligence either. But that's beside the point.

I was ready. Had to be. Said so to the Brigadier.

"O.K. Shall leave by the evening."

Thought I could still manage the lunch and the movie leaving the shopping to Lali. I get bored amid all these heaps of sarees anyway. But the Brigadier brought me down to earth.

"Sorry again. It's an SOS. The big bird's waiting outside rearing to fly off. Leave right here. I'll do the explaining to Lalita baby. Don't waste any time. Get cracking."

"Yes Sir!" And that was that. No questions asked. I saluted him again and ran to the chopper whirling its blades like a mixie gone mad.

It didn't take all of an hour and a quarter to reach the intelligence HQ. But even during that short hop I got half a dozen radio messages asking me to hurry. The jeep at the helipad had its engine running even as we touched down.

Five minutes later I was inside the HQ. The Intelligence Chief was bloody anxious. I could tell. He cut out the malarkey about salutes and literally dragged me by the arm to the operation theatre. He let me see for myself. Didn't say a word. Didn't have to.

It was a job for me and me alone, I could see. Well, not the details but I got a glimmer of the idea...

A bloke was lying on the table. A good physique but battered. What ghoulish wounds! Looked as if he'd lost a lot of blood. And the fractures! The femur dangling at a crazy angle... The cardioscope was attached. But the fluorescent spot was marching in a straight line. As if it too had donned an uniform. It was straight like a prig's walk. The bird had flown the coop. You know what I mean? Indication that the heart had bid bye-bye. The EEG was connected too. That signal was fairly healthy. So the brain was still on... But it looked dicey...

For a couple of minutes nobody uttered a word. As if everyone was afraid that even the slightest sound might cause the EEG signal to stop.

Then the Chief cleared his throat: "Well Doctor! What do you make of it?" I didn't reply. What could I say? Rather busied myself playing around with a

borrowed stethoscope. Flashed some light in his eyes. The brain, too, seemed on its way out.

It was the Chief again who broke the silence:

"Doctor, meet our physician, Amarjeet Singh." The tall, athletic Sikh saluted stiffly. He was a Captain.

"Captain," I offered my hand.

"Doctor, Amarjeet here says that even if the patient's heart is not responding, his brain is still showing signs of normal function. So he can't be considered to have died. Do you agree?"

"Yes Sir. When the heart transplants first got going in the late 'sixties some of these legal and ethical complications *had* arisen. A lot of arguments were bandied about then. And the upshot was that as long as the brain shows signs of normal functions a man's not to be considered dead, at least not clinically dead."

"OK, OK, Doctor," the Chief cut me short somewhat impatiently. "We all agree that this patient here is not yet dead. He *is* alive. Jolly good! Can you revive him fully? His brain's still okay. Only the heart's gone. Can you stitch one on? Replace it I mean. Everything should be hunky dory then. That's why we called you. Give him a transplant."

"A transplant! To him! Now?" In the name of Heaven, I couldn't believe my ears. "But, but..."

"But what, Doctor?"

"But, how's that possible?"

"Why not? What's your problem?"

"The surgery is not a simple one. Need a lot of preparation before you get on. A heart lung machine. Then a cryostat. Need a large operating team. The patient too has to be readied in a number of ways. Quite a few injections have to be given."

"Amarjeet will take care of that."

"But the main thing—the donor heart. Where are you going to find one? And even if you do get one—it's got to be tested thoroughly. Tissue typing has to be performed. Like the blood groups, we got to match histocompatibility groups. Otherwise the recipient body throws it out, rejects the grafted heart later on."

"That's it! Even if the rejection takes place, that will come later. Won't it? Even if you can bring him back to life for a few days that'd be enough."

"But—but—where'd you get such a heart?"

"I'll get it! I'll get it! The search is on. And if that fails we'll have a volunteer."

"You can't be serious?" I raised my voice. "You mean—you—you will kill a God's good man, a living man? Just to get at his heart?"

Well you know how I am. All these years in the army have not still dulled my sensitivities.

"Oh! Cut out that sentimental mush, will you!" The Chief shot back. "I'll have to order you."

"Please Sir, try to understand. Even if you get all that in readiness, there's no hope that the operation will succeed. The patient's condition is hopeless. I doubt if the patient will come round even if the operation is successful."

"Doctor, I'll be blunt with you. It is highly imperative that this chap here be revived and be able to talk. We just need an hour or two. That's all. Give him just that much life with your transplant."

"But why? What's the hurry?"

"None of your business."

The Chief blew his top. He was livid with rage. Then he steadied himself and continued in a calmer tone: "Doctor, this is an intelligence unit. We work here on a need-to-know basis. All that I can tell you is that the man's in possession of a top secret, strategically crucial information. Now, give me your final verdict."

My mouth had gone dry. I tried in vain to moisten my lips. Approached the patient again and started examining him carefully. Better to do that than talk I thought. Looked through all the records of the previous hour. Thumbed through the cardiogram charts. Concentrated on the EEG traces. Calculated and recalculated. All that frenetic activity gave me a dull ache behind my ears. But the conclusion was unchanged. If at all, the chances were growing slimmer by the minute. I shook my head in despair.

"Sorry Sir. I'll operate if you order me to do so. But the chances are very slim. So slim that you won't get the information you so badly need. On top of it you'd lose a healthy, sound volunteer. I leave the decision to you Sir."

The Chief collapsed in the nearby chair. "Oh no, Doctor! Please, I was banking on you. All your experience,

vour special training, your..."

"Yes Sir. All that's there! But... but I'm not God!"

"Is there no way out then?"

"Excuse me Sir. I'm fully aware that I do not figure into your need-to-know list. But if you can explain it all? Perhaps I might find a solution After all I too belong to the army I know its discipline. I too can keep secrets. It..."

So critical must have been the situation that the Chief broke his resolve That's why he decided to tell me all. Wish he hadn't gone so soft then This entire predicamant wouldn't be staring us in the face now

The Chief began:

"Doctor, this young man Captain Sadashiv Gokhale He was—is was my best operator "

The Chief was all at sea with his tenses

"I had sent him on a special mission, a most dangerous one To get behind the enemy lines and get their war plans. They aim to launch a preemptive strike But our supersonic fighters are yet to arrive. We need to buy time. I am sure that the outcome of the war hinges on this initial skirmish That's why we need all this information. Moreover, were we to confront the enemy with such hard evidence of their war plans then we could score over them on the diplomatic front and win the battle there Maybe we can avert the war altogether. Sadashiv- our code name for him was Bhausaheb, (after the Peshwa)—was on this sensitive mission. He had come out on top and even given us a radio message of 'Thumbs up' He had started on his way back and we were eagerly waiting for him. Possibly at the last minute his cover got blown He was thrown across the border in this condition. They thought he was dead, I am sure Even we gave up on him while bringing him here. His heartbeat was faint, barely audible ble. Now, even that has stopped It's a grievous loss. I genuinely liked that boy. But more vital is this information which he's managed to carry in his head. That won't be available. Worst of all the enemy's been alerted. They might advance their plans. There's no way we can send a replacement. It's a total fiasco, this mission. And if we lose the war on account of that..."

The Chief choked on his words He was overcome with emotion.

For a while there was total silence. You could have literally heard the proverbial pin drop

It was just that moment I am positive. It was just that moment when the thought first hit me. I got a jolt as if a land mine had exploded under my feet I tried to push the thought away But the possibilities, the challenge, the sheer opportunity it offered excited me.

"Sir," I asked, "is it possible that Sadashiv kept a record of this information somewhere? In code perhaps!"

"Impossible. Unthinkable. Nobody could commit such a blunder. Not certainly Sadashiv. That information he kept to himself, safe in his head."

"In that case, Sir, I have an idea See what you think of it. It it works, you'll have your information. Sadashiv's martyrdom would not be in vain I'll certainly need the volunteer you promised but we won't have to sacrifice him."

"Go ahead Spell it out. Quick Don't beat around the bush "

"But let me warn you Sir This scheme's out of this world. A shot in the dark There is no guarantee that it will work Still...."

"Let me decide that Shoot, man, shoot!"

"Sir, although I am a surgeon, a heart transplant expert, my first love is, has always been, neurophysiology I have kept pace in that direction. Do a spot of research from time to time."

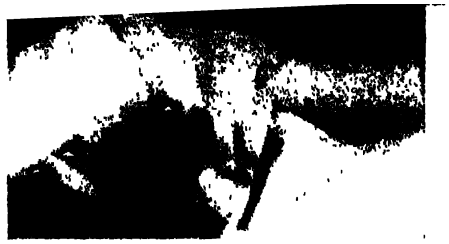
"Come to the point my dear fellow, Go on

"Sir, a chap called McConnel conducted an interesting experiment on tape worms. And Ungar, a Hungarian immigrant scientist extrapolated it to rodents Mice to be precise. And mice and men are pretty close physiologically. That's why the results from these mice experiments can almost always be extended to us *Homo sapiens.*

"Now it's common knowledge that mice normally prefer darkness. They shun light. The house rat for example. You rarely see him anywhere during daytime. At nightfall it's a different story. He's king then. Starts scurrying around. During the day they hide away out of sight in some dark crevices, some underground holes. Well Ungar had built his experiment around this characteristic.

He built a special cage that was divided into two halves. One was brightly lit while the other was kept in total darkness. He housed some mice in this cage. Food and water were kept in the bright half. But the mice wanted no part of that. They would raid the bright half, grab a mouthful and scamper over to the dark side. So Ungar improvised his cage by connecting a live electric circuit to the dark side. So that the moment a mouse stepped into that side he would receive a jolt. Not sufficient to maime or kill him, mind you. But enough to scare him, to make him hurry back *to the bright side. This went on for a while. Till the mice learnt a lesson They developed* a fear of darkness. *They began to prefer the bright side* even when the electric circuit was turned off! *In fact to make sure, Ungar switched the food over to the dark side But the mice would take it away to the bright side!*

Once he became certain that the memory of this fear for darkness was firmly implanted in their brains, Ungar moved on to the next stage of the experiment At that time the scientists had hypothesised that long term memory resides in a particular part of the brain and is stored in a chemical form in the molecules of the nucleic acid RNA Ungar killed the mice which he had trained to fear darkness, dissected out their brains, extracted the RNA from the memory-containing portions and injected it into fresh, untrained mice. To his satisfaction he found these new mice also beginning to display a fear of darkness. The hypothesis that memory resides in RNA was thus substantiated. Naturally more experiments were performed, are



being performed with the theory gaining considerable ground."

"Thank you, Doctor for educating me." The Chief's words were positively dripping with sarcasm. "But pray tell me what has all this got to do with the problem on hand?"

"I was coming to that, Sir. That's why I asked you a while ago about the possibility of Sadashiv having maintained a record of his information somewhere. Since that is nonexistent, Sadashiv must have retained its memory in the same form that these mice did. So, now if I were to extract the RNA from the memory retaining part of his brain and inject it into another bloke he should be able to translate that chemical language into one that we can easily follow. Like the tape recorder which records music on a tape into a sort of magnetic score. And the cassette faithfully reproduces the original music whichever recorder we choose to replay it. But you need a fresh brain, a volunteer. Now you know why..."

"Bravo! Bravo!" The Chief crushed me in his arms in his excitement. "Brilliant, Doctor, brilliant."

"Hold on! Hold on," I tried to put the damper on his enthusiasm. "Might have sounded simple while I was relating it. But it's going to be a mighty risky experiment. Can't guarantee its success. Nobody's ever done it. Nobody in his senses ever would perform one. I wouldn't either. Because there are a good many restrictions on human experimentation and rightly so. I shall be branded a criminal for indulging into such an experiment. But you don't care much for such ethical niceties. And keep it all under the hat. That's why am offering to do it. Nonetheless should warn you of its consequences."

"I assume full responsibility. Just you go ahead. Only let me know what you need."

"I will. The volunteer has to be young. Hale and hearty. Better if he is single. So won't have to face his wife if anything should go wrong."

The memory of Lali's birthday must have been lurking in some dark corners of my mind.

We didn't waste much time thereafter. I had total command. Though the post operative health of the patient was of no concern in this case, the operation had still to be carried out with the same degree of care, the same degree of skill.

Well, Boy, did we sail along merrily? You bet. In the name of Heaven, getting out the RNA from Sadashiv's brain was no problem at all. The volunteer the Chief produced—Vishwanath Karande—was a strapping young man, a stallion. I had insisted that he had the same mother tongue as the dear departed Sadashiv. Didn't want any mixing of lingos to cause any more snafus. Injected him with the RNA extracted from Sadashiv's brain. A day later the first faint sirens of its effect were heard. We let another couple of days go by and then sat down with a tape recorder. While I tested his physiological functions the Chief started his interrogation. He asked him straight questions, leading questions, tricky ones to test his veracity, asked for passwords only Sadashiv was privy to In short he ensured that the message Vishwanath was replaying was the real potato. It was a day with 26 hours. We were all exhausted when it ended but on top of the world.

Our experiment had come out a corker. Exceeded all our expectations. The Chief got all that he needed And that gave the required edge to our diplomatic offensive. We averted the war. But you have read all that in the press, old chap.

My own personal exhilaration would be beyond you unless you happen to be a scientist.

The Chief congratulated me heartily Promised a recommendation for the PVSM and a promotion to full Colonel next year

It was a full week since I had left home in a hurry. Lali must have worried herself sick. The Chief had no hesitation now in letting me go. Vishwanath too appeared in good shape.

So the prodigal returned home. Lali's birthday celebration went on for a full week.

A month must have lapsed in between. Time flies. I was again summoned by the Chief. Vishwanath's condition must have taken a turn for the worse, I thought. Maybe an adverse or allergic reaction. Didn't lose any time reaching the HQ. Even before the Chief could say anything I enquired about Vishwanath.

"Well, he is allright," said the Chief tersely and threw a letter across to me.

I opened it. The thin slanted script on rose paper betrayed a feminine hand. The signature at the end, "Parvati", confirmed it. Couldn't make anything out of it So I looked at the Chief with a quizzical expression.

"Sadashiv's wife," the Chief replied but that didn't answer my questions.

And the letter only complicated matters. Parvati had one long bitter plaint. What had the HQ done to her husband? She demanded. He had undergone a sea change. He was her husband alright. But looked different. Acted different. Even the physique was different. So the army must have cast some kind of spell on him. And she wanted to know!

That had me bowled over. Sadashiv was dead and gone. Saw to his cremation myself. Who was this Johnny then trying to take advantage of the poor girl?

"Didn't you inform her of Sadashiv's death?"

"We did. That's why I smell a rat here. Could be an enemy agent you know "

"But I can't get this Parvati. She admits that this bloke is different from Sadashiv in more ways than one. How is she convinced then that he is Sadashiv and not an imposter?"

"That knocks me out too Maybe the psychological tension has been too much for the girl. She has finally come unhinged. That's why called you. Let's go pay her a visit. Shall we?"

"Right ho Sir."

It was Parvati who answered our knock. The moment we introduced ourselves she let us have an earful. Even the enemy flak would be milder.

But how can I convince Parvati? It would psyche her out! Play havoc with her emotions! How could I tell her...

"What have you done to him Sirs?" she appealed. "When he left here he was so happy, so healthy, so considerate. And now, he is different. It's not just his face, or physique or—or—can't explain it. But he has changed. Radically."

"That's it. He is not Sadashiv, my dear." The Chief tried his best PR accent. "Sadashiv laid his life for the country. Died a hero's death. I am sorry to..."

"No! No! He is alive and well. Having a nap over there."

"But you admit that he—the one over there—doesn't look like Sadashiv Doesn't act like him. Then—how—wouldn't he be an imposter, dear?"

"No Sir. I am sure it's him all right. How else would he know all the details of his life, our life, his childhood. And—And—" she hesitated. But with a renewed determination and a defiant look said:

"—and even the shared intimacies that only the two of us would know."

The bounder was a real rascal No doubt. We asked her to wake him The Chief readied his gun.

That moment he stepped into the room

You could have knocked us down with a feather then.

It was Vishwanath.

"You, you scoundrel—" I cut the Chief short. For it had dawned on me, what must have happened Somehow I pacified Parvati. Yes, the Chief too and dragged him out. But I asked Vishwanath to accompany us A brief chat with him was all I needed. My hunch had proved right.

We left him there and started back.

As the jeep accelerated I asked the Chief "Why didn't you tell me when I asked you about Vishwanath"

"Said he is all right, didn't I? You saw it for yourself. I readily sanctioned his leave once our basic mission was accomplished. How was I to know that the blighter would come here? Take the girl for a ride?'

"It's not his fault Sir. Don't you see what has happened? The memory of all the knowledge Sadashiv had acquired during his life time was stored in his brain. The information we were seeking was but a tiny miniscule part of that. But we extracted all the RNA and when Vishwanath was injected with it the whole memory got transplanted. That's the reason he genuinely believes that he is Sadashiv. Its able to convince Parvati of that. And then his own memory. That's intact and has got entangled with the transplanted one. It's one big mess. Like a tape on which something is recorded without totally erasing what was there in the first place. Like a doubly exposed film."

I was able to explain it all to the Chief. But how can I convince Parvati? It would psyche her out! Play havoc with her emotions? How could I tell her that her husband was used as a guinea pig? And then she is not alone. There's Vishwanath. He is all confused now. Wouldn't it get worse if I am to tell him all? Don't want to be responsible for so messing up two lives!

Ah lordy! All these years in the army have not dulled my sensitivities.

Now you know! Ever since that day we are caught in this maze. Me and the Chief. Particularly me. Can't think straight any longer. Have been spending sleepless nights. Sadashiv's ghost has been haunting me. See if you can find a way out.

Drop me a line when you do.

Just address it to Colonel Jamkhedkar, Army Medical Corps, New Delhi.

AWARDS AND APPOINTMENTS

PROF. SIDDIQI ELECTED FRS

PROF Obaid Siddiqi was elected a Fellow of the Royal Society on 15 March, 1984 His major contributions are in the fields of microbial molecular genetics and the genetics of chemosensory perception in *Drosophila.*

Prof Siddiqi joined the Tata Institute of Fundamental Research (TIFR), Bombay in 1962 and set up the Molecular Biology Unit in the Physics faculty of the Institute, the first research group of its kind in India He was a visiting professor of biology at the Massachusetts Institute of Technology (1970-71) and was also a Sherman Fairchild Distinguished Scholar at the California Institute of Technology (1980-81). In 1976, he won the Bhatnagar Prize in Biological Sciences instituted by the Council for Scientific and Industrial Research. Prof. Siddiqi is vice-president of the Indian Academy of Sciences and a Fellow of the Indian National Science Academy. He also a member of the Cabinet's Scien Advisory Committee On Republic Day thi year he received national recognition fo his contribution to Indian science, in tl form of the Padma Bhushan

Prof Siddiqi is one of the early discoverers of suppressors of 'nonsense mutations' phenomenon which led to the elucidati of stop signals in the genetic code. His wo has also thrown light on the transfer recombination of DNA in bacteria. His recent studies are concerned with understanding the mechanisms of smell and tas and the role of genes in the organisation the nervous system.

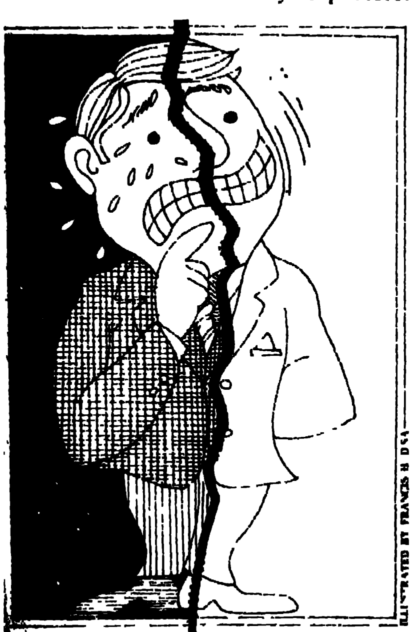
Countries like India have modest resources and comparable power programme

Continued from page 47

Uranium resources of the world

Because of the global interest in uranium resources there are a number of organisations which periodically publish information on world uranium resources. The International Atomic Energy Agency (IAEA) is one of them. According to their recent estimates, the total uranium resources of the world stand at about 5,000,000 tons. However, the distribution among different countries is uneven. Australia, Brazil, Canada, Namibia, Niger, South Africa, the United States of America and France account for about 85 per cent of the world resources.

The domestic resources and internal demand for uranium form a complex pattern. Countries like USA and France have relatively large uranium resources to meet possible demands. Countries like UK, West Germany and Japan have large nuclear power programmes but practically no domestic uranium resources and are therefore dependent on imports. Countries like Canada, Australia, South Africa, Niger and Namibia have great potential for uranium but insignificant nuclear programmes and hence are essentially exporters.



The two faces of uranium— hope and fear

Unconventional sources of uranium

IN addition to the ores which can be processed for recovering 'yellow cake', several other sources of prospective utility have been identified and investigated. For example, phosphate rock which is a raw material for production of phosphoric acid and phosphate fertilizers contains a small amount of uranium about 0.1 kg per ton. Several processes are now being advocated for producing uranium, as a by-product, from this source.

Sea water contains minute concentration of uranium (about 1 gm in 300 tons of water) but the total uranium present in the ocean is 4,000,000,000 tons. It is a challenge to the technologist to exploit this vast reserve of low concentration. Active research is on in some countries like Japan and West Germany to evolve processes for recovery. However, all these efforts have yet to come to a state of economic feasibility.

These and some other unconventional sources of this type may prove valuable to some countries not endowed with liberal ore reserves.

T.K.S.M.

Countries like India have modest resources and comparable power programmes.

The uranium industry has grown dramatically in 30 years from virtually no production in the 1950s to around 40,000 tons of uranium in the 1980s. At present the principal industrial use of uranium is as fuel in nuclear reactors. The other principal use is as a base raw material for the production of explosive devices. Because of this dual role the production, marketing and use of uranium have been and continue to be subjected to Government control and intervention.

The position of uranium resources and production given above does not include statistics from the communist world.

Status in India

In India all matters pertaining to uranium and nuclear energy come under the jurisdiction of the Department of Atomic Energy. The Atomic Minerals Division (Hyderabad) is entrusted with the responsibility of prospecting for uranium minerals and establishing the ore reserves. According to the recent IAEA report, the total uranium resources of India are in the range of 60,000 tons. Most of the proved deposits are in the Singbhum area of Bihar. Uranium Corporation of India Ltd., (UCIL) is operating a uranium mine and a mill at Jaduguda, a place about 40 km from Tatanagar, producing 'yellow cake'. Further refining of this product is done in Trombay and at the Nuclear Fuel Complex (NFC), Hyderabad. At Trombay, uranium metal is produced and converted into fuel elements for use in the research reactors located at BARC At NFC, uranium oxide, both natural and isotopically enriched (from UF_6 received from the US and presently from France) is produced and fuel bundles suitable for the operating power reactors at Tarapur, Kota and Kalpakkam assembled. Reprocessing facilities are available at present at Trombay and Tarapur. Additional facilities for producing uranium concentrates, nuclear fuel and reprocessing are planned to meet increasing demand as the nuclear programme of the country expands. Thus, India is self sufficient in natural uranium, but for the present enriched uranium required only for the reactors at Tarapur is procured from abroad.

The Uranium industry encompasses a number of operations starting with exploration, going through mining, milling, refining, isotopic enrichment, fuel fabrication and finally reprocessing. India is one of the few countries in the world where the technological base for almost all branches of this industry is firmly established. □

Mr. Murthy is Head, Uranium extraction Division, Bhabha Atomic Research Centre, Bombay.

THERE IS UNEMPLOYMENT AHEAD FOR ENGINEERS

ARE you planning to go in for engineering? Job prospects for engineers are going to be pretty bleak soon. There is already a surfeit of engineers in the conventional areas like civil, mechanical and electrical. And thanks to the recent rash of engineering colleges, particularly in the South, the situation is going to be even worse.

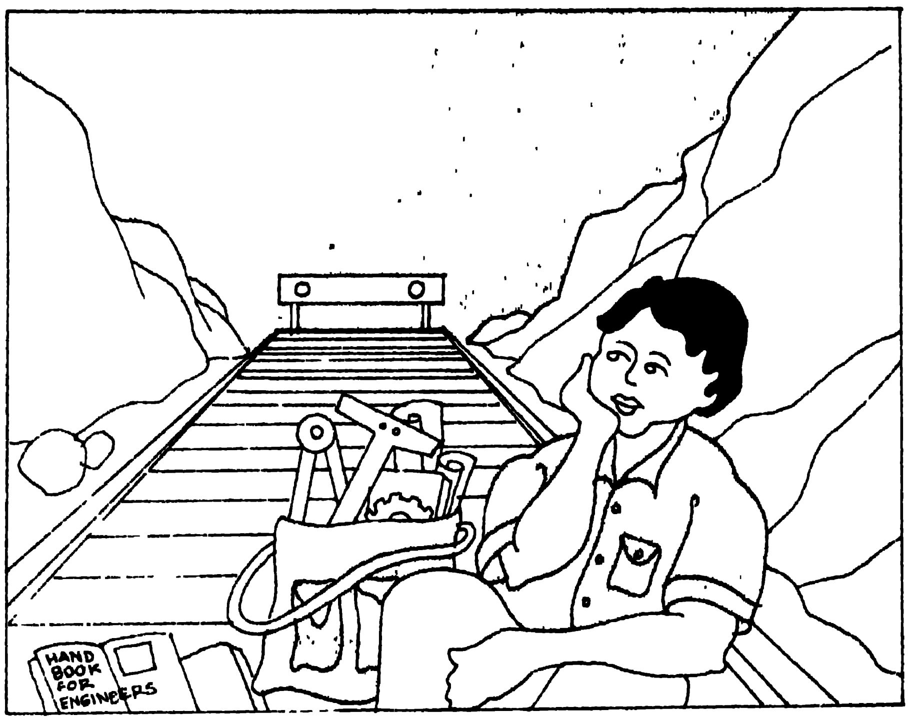
There is an unwarranted growth in technical educational facilities, particularly in traditional courses like civil, mechanical and electrical. About 25,000 to 27,000 engineers and technologists turn out from our colleges every year, while there are jobs only for 15,000 to 17,000 Thus there will be 21,000 unemployed engineers and technologists by the end of next year (when the Sixth Five-Year Plan ends). The situation is likely to worsen during 1985-90 (the Seventh Plan period) when the 29 engineering colleges set up in Karnataka and Andhra Pradesh in the late 1970s by private agencies start turning out graduates in full swing. These colleges are, of course, not recognised by the All-India Board of Technical Education.

In 1977, a Special Committee reported that the annual admission capacity of 25,000 for the first degree engineering course approved by the All-India Council for Technical Educationl is more or less adequate to meet the likely requirement of engineers even upto 1987. The committee had also recommended that the technical institutions already existing should be able to expand their facilities and that there is no need to start any new institution at least for the next ten years. Despite this report, there has been an indiscriminate growth in the number of colleges, and soon there will be too many engineering graduates around. This will in turn frustrate them, and will force them either to work on low salaries or remain unemployed It is time the government reviewed the situation

As for the turnout of graduates in various branches of engineering, by and large, disciplines like mechanical, electrical and telecommunications electronics have grown well during the 15 years from 1971 to 1986 Telecommunications and electronics is, of course the fastest growing area (400 per cent) followed by textile and architectural engineering (156 per cent each). The number of graduates in the rest of the branches will increase from 106 per cent to 148 per cent during this period.

All these statistics are important if you realise that science and technology play a very decisive role in economic development. And to utilise the available equipment and knowledge well, it is essential to train and develop manpower in a way that it helps exploit science and technology in boosting agricultural, industrial and even defence production efficiently. To ensure the trained personnel are effectively interwoven with the projects of national development, it is also necessary to assess these qualified technical manpower in terms of their availability, demand, educational facilities, and hence check any imbalance.

Let us, therefore, take a wide overview of the present and future position of first degree engineers/technologists in terms of their intake, outturn, stock, employment and unemployment during 1970-71 to 1985-86. Technical education in India in the past 35 years has been organised and expanded, as per recommendations made by various technical committees, which has resulted in a surge of institutions, and hence in the intake and outturn of graduate engineers and technologists.



In the history of engineering education, two periods can be clearly identified: (i) when admissions were restricted in the late 1960s following a nation-wide economic recession and this had an inverse impact on the outturn of engineers in the early 1970s, and (ii) when new colleges started opening in the late 1970s which had a favourable impact on the outturn in the 1980s. The data have been analysed keeping in view these two periods.

Table 1 shows the trend in the growth of engineering facilities in terms of number of institutions, their intake and outturn during 1970-71 to 1980-81. During 1970-71 to 1975-76, there was no increase in the number of institutions and the outturn fell by 23 per cent, while in later years (1975-76 to 1980-81) there was an increase in the number of institutions (24 per cent), the outturn (36 per cent), and intake (47 per cent). This means there will be a rapid growth in the outturn of engineers and technologists in 1984-85 and thereafter when the 29 institutions newly set up around 1978-79 will start producing new graduates. The total outturn is expected to be of the tune of 25 to 27 thousand in 1984-85 and may rise to around 27 to 29 thousand in subsequent years.

Region-wise, the southern region has taken a lead in the growth of technical educational facilities after 1975-76. Out of the 31 colleges set up during 1975-76 to 1980-81, 29 alone are in this region—20 in Karnataka and 9 in Andhra Pradesh. These institutions have been set up by the non-government agencies. They also charge capitation fee for admissions, and are not

recognised by the All-India Council for Technical Education. As a result, there was a more than 100 per cent increase in the intake of first degree engineers and technologists in the southern region, in contrast to 21 per cent in the western region, 15 per cent in the northern region and a fall of about 12 per cent in the eastern region. In the case of the outturn of the engineers/technologists, however, the highest growth has been in the western region (83 per cent) and the lowest in the northern region (5 per cent). In the southern and eastern regions, it has been about 47 per cent and 32 per cent, respectively.

Table 1

Years	No. of colleges	Intake	Outturn
1970-71	130	17,492	17,442
1975-76	130	21,491	13,496
1980-81	161	31,496	18,381

How were the engineers distributed among the various branches during 1970-71 to 1980-81? Mechanical (29%), civil (24%), electrical (20%), and chemical (6%), were the major disciplines to which telecommunications/electronics (8%) has lately been added. Together, they accounted for more than 85 to 90 percent of the total outturn of graduate engineers and technologists during the period. Except telecommunications/electronics, chemical and 'other', all the specialities showed a decrease in their outturn during 1970-71 to 1975-76, while not a single branch of engineering/technology has shown a fall in its outturn during the period 1975-76 to 1980-81. During these latter five years, the highest growth was in civil engineering (45%) followed by mechanical engineering (43%), telecommunications/electronics (42%), architecture (42%), and electrical engineering (36%); this indicates that work in these areas had expanded considerably in the country during the late 1970s. The lowest growth was in chemical engineering (9%), which is otherwise considered important for the development of the various industries like medicines, pharmaceuticals, fertilizers, cement, etc, and in textile engineering (12%).

Is there any mis-match in the supply and demand of engineers? What is our total stock of engineers and technologists? Let us start with 1971 as the base year. While there were a total of 1,50,200 engineers and technologists in the country in 1971, it increased to 2,70,200 in 1981 and is estimated to be 3,37,300 in 1986. This means a total increase of 125 per cent since 1971, and an annual increase of 8 per cent. Speciality-wise, the number of telecommunications/electronics engineers by 400 per cent followed by textile and and architecture (156%)

Table 2: Estimates of stock of economically active and unemployed engineers and technologists (in thousands)

	1981	1986
Stock	270.2	337.3
Economically active population (labour force stock)	235.1	293.5
Unemployed	16.7* (16.9)	20.8* (20.8)
Employed	218.4	272.7
Additional employment (1981-86)	54.3	
Replacement needs (1981-86)	24.3	
Job opportunities (1981-86)	78.6	

*Worked out on the basis of unemployment rates provided by the Planning Commission in the Sixth Five-Year Plan Document, Table 13.9, p. 220.
Figures within brackets represent the number of unemployed graduate engineers and technologists based on registration data of the Live Register of the Employment Exchanges (DEG&T, New Delhi) after applying the correction factor.

The highest growth, of about 179 per cent, in the stock of engineers has occurred in the southern region. This growth has occurred largely during 1981-86 because of the opening of 29 new engineering colleges in this region during 1976-80. Karnataka, says a study conducted by the Indian Institute of Management, Bangalore, "has almost set a world record by establishing the largest number of engineering colleges within the shortest period". The growth in the western and northern regions was 133 per cent and 126 per cent, respectively. On the other hand, the eastern region shows only a moderate growth of about 60 per cent.

Information on the employment position of engineers is not readily available for the last decade, and so we cannot work out the correct figures for this decade. However, using various estimates of unemployment among graduate engineers and using data from employment exchanges, one could say there were 16,700 to 16,900 unemployed engineers and technologists in the country in 1981, and 20,800 engineers would be unemployed in 1986.

On the next page is a list of engineering colleges in the country

Engineering colleges—p. 58

R. G. Varshney
B. L. Agarwal

The authors are working as Joint Chief and Chief (Research), respectively, in the Institute of Applied Manpower Research, New Delhi. The views expressed here are those of the authors and not necessarily those of the organisation to which they belong.

THERE IS UNEMPLOYMENT AHEAD FOR ENGINEERS

ARE you planning to go in for engineering? Job prospects for engineers are going to be pretty bleak soon. There is already a surfeit of engineers in the conventional areas like civil, mechanical and electrical. And thanks to the recent rash of engineering colleges, particularly in the South, the situation is going to be even worse.

There is an unwarranted growth in technical educational facilities, particularly in traditional courses like civil, mechanical and electrical. About 25,000 to 27,000 engineers and technologists turn out from our colleges every year, while there are jobs only for 15,000 to 17,000. Thus there will be 21,000 unemployed engineers and technologists by the end of next year (when the Sixth Five-Year Plan ends). The situation is likely to worsen during 1985-90 (the Seventh Plan period) when the 29 engineering colleges set up in Karnataka and Andhra Pradesh in the late 1970s by private agencies start turning out graduates in full swing. These colleges are, of course, not recognised by the All-India Board of Technical Education.

In 1977, a Special Committee reported that the annual admission capacity of 25,000 for the first degree engineering course approved by the All-India Council for Technical Education) is more or less adequate to meet the likely requirement of engineers even upto 1987. The committee had also recommended that the technical institutions already existing should be able to expand their facilities and that there is no need to start any new institution at least for the next ten years. Despite this report, there has been an indiscriminate growth in the number of colleges, and soon there will be too many engineering graduates around. This will in turn frustrate them, and will force them either to work on low salaries or remain unemployed. It is time the government reviewed the situation.

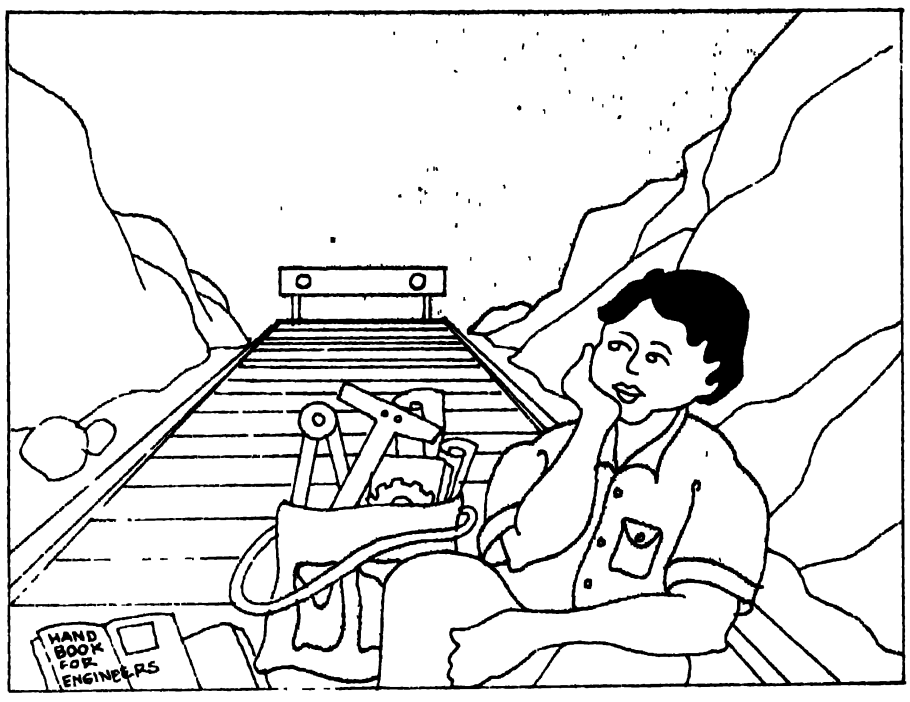
As for the turn out of graduates in various branches of engineering by and large, disciplines like mechanical, electrical and telecommunications electronics have grown well during the 15 years from 1971 to 1986. Telecommunications and electronics is, of course, the fastest growing area (400 per cent) followed by textile and architectural engineering (156 per cent each). The number of graduates in the rest of the branches will increase from 106 per cent to 148 per cent during this period.

All these statistics are important if you realise that science and technology play a very decisive role in economic development. And to utilise the available equipment and knowledge well, it is essential to train and develop manpower in a way that it helps exploit science and technology in boosting agricultural, industrial and even defence production efficiently. To ensure the trained personnel are effectively interwoven with the projects of national development, it is also necessary to assess these qualified technical manpower in terms of their availability, demand, educational facilities, and hence check any imbalance.

Let us, therefore, take a wide overview of the present and future position of first degree engineers/technologists in terms of their intake, outturn, stock, employment and unemployment during 1970-71 to 1985-86. Technical education in India in the past 35 years has been organised and expanded, as per recommendations made by various technical committees, which has resulted in a surge of institutions, and hence in the intake and outturn of graduate engineers and technologists.

In the history of engineering education, two periods can be clearly identified: (i) when admissions were restricted in the late 1960s following a nation-wide economic recession and this had an inverse impact on the outturn of engineers in the early 1970s, and (ii) when new colleges started opening in the late 1970s which had a favourable impact on the outturn in the 1980s. The data have been analysed keeping in view these two periods.

Table 1 shows the trend in the growth of engineering facilities in terms of number of institutions, their intake and outturn during 1970-71 to 1980-81. During 1970-71 to 1975-76, there was no increase in the number of institutions and the outturn fell by 23 per cent, while in later years (1975-76 to 1980-81) there was an increase in the number of institutions (24 per cent), the outturn (36 per cent), and intake (47 per cent). This means there will be a rapid growth in the outturn of engineers and technologists in 1984-85 and thereafter when the 29 institutions newly set up around 1978-79 will start producing new graduates. The total outturn is expected to be of the tune of 25 to 27 thousand in 1984-85 and may rise to around 27 to 29 thousand in subsequent years.



Region-wise, the southern region has taken a lead in the growth of technical educational facilities after 1975-76. Out of the 31 colleges set up during 1975-76 to 1980-81, 29 alone are in this region—20 in Karnataka and 9 in Andhra Pradesh. These institutions have been set up by the non-government agencies. They also charge capitation fee for admissions, and are not

recognised by the All-India Council for Technical Education. As a result, there was a more than 100 per cent increase in the intake of first degree engineers and technologists in the southern region, in contrast to 21 per cent in the western region, 15 per cent in the northern region and a fall of about 12 per cent in the eastern region. In the case of the outturn of the engineers/technologists, however, the highest growth has been in the western region (83 per cent) and the lowest in the northern region (5 per cent). In the southern and eastern regions, it has been about 47 per cent and 32 per cent, respectively.

Table 1

Years	No. of colleges	Intake	Outturn
1970-71	130	17,492	17,442
1975-76	130	21,491	13,496
1980-81	161	31,496	18,381

How were the engineers distributed among the various branches during 1970 71 to 1980-81? Mechanical (29%), civil (24%), electrical (20%), and chemical (6%), were the major disciplines tc which telecommunications/electronics (8%) has lately been added. Together, they accounted for more than 85 to 90 percent of the total outturn of graduate engineers and technologists during the period. Except telecommunications/electronics, chemical and 'other', all the specialities showed a decrease in their outturn during 1970-71 to 1975-76, while not a single branch of engineering/technology has shown a fall in its outturn during the period 1975-76 to 1980-81. During these latter five years, the highest growth was in civil engineering (45%) followed by mechanical engineering (43%), telecommunications/electronics (42%), architecture (42%), and electrical engineering (36%); this indicates that work in these areas had expanded considerably in the country during the late 1970s. The lowest growth was in chemical engineering (9%), which is otherwise considered important for the development of the various industries like medicines, pharmaceuticals, fertilizers, cement, etc, and in textile engineering (12%).

Is there any mis-match in the supply and demand of engineers? What is our total stock of engineers and technologists? Let us start with 1971 as the base year. While there were a total of 1,50,200 engineers and technologists in the country in 1971, it increased to 2,70,200 in 1981 and is estimated to be 3,37,300 in 1986. This means a total increase of 125 per cent since 1971, and an annual increase of 8 per cent. Speciality-wise, the number of telecommunications/electronics engineers by 400 per cent followed by textile and and architecture (156%)

Table 2: Estimates of stock of economically active and unemployed engineers and technologists (in thousands)

	1981	1986
Stock	270.2	337.3
Economically active population (labour force stock)	235.1	293.5
Unemployed	16.7* (16.9)	20.8* (20.8)
Employed	218 4	272.7
Additional employment (1981-86)	54.3	
Replacement needs (1981-86)	24.3	
Job opportunities (1981-86)	78.6	

*Worked out on the basis of unemployment rates provided by the Planning Commission in the Sixth Five-Year Plan Document, Table 13.9, p. 220.
Figures within brackets represent the number of unemployed graduate engineers and technologists based on registration data of the Live Register of the Employment Exchanges (DEG&T, New Delhi) after applying the correction factor.

The highest growth, of about 179 per cent, in the stock of engineers has occurred in the southern region. This growth has occurred largely during 1981-86 because of the opening of 29 new engineering colleges in this region during 1976-80 Karnataka, says a study conducted by the Indian Institute of Management, Bangalore, "has almost set a world record by establishing the largest number of engineering colleges within the shortest period". The growth in the western and northern regions was 133 per cent and 126 per cent, respectively. On the other hand, the eastern region shows only a moderate growth of about 60 per cent.

Information on the employment position of engineers is not readily available for the last decade, and so we cannot work out the correct figures for this decade. However, using various estimates of unemployment among graduate engineers and using data from employment exchanges one could say there were 16,700 to 16,900 unemployed engineers and technologists in the country in 1981 and 20,800 engineers would be unemployed in 1986.

On the next page is a list of engineering colleges in the country

Engineering colleges—p. 58

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ENGINEERING COLLEGES IN INDIA

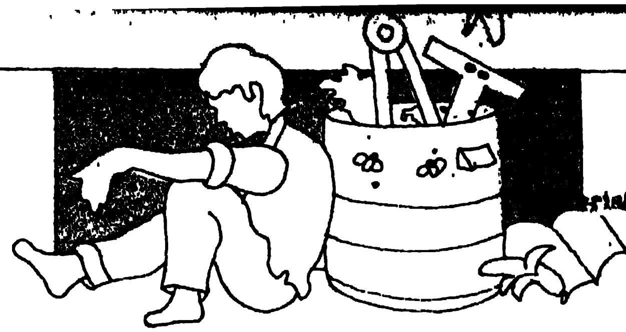
Technical institutions offering degree and equivalent engineering and technology courses

HS=Higher secondary, CBSE=Central Board of Secondary Education, PUC=Pre-university course, PE=Pre-engineering, Inter=Intermediate, I.Sc=Intermediate science, JEE–Joint Entrance Exam, PD=Pre-degree, P-prof=Pre-professional)

	Institution and affiliation	Type of institution	Duration of course (years)	Qualification
	1	2	3	4
	NORTHERN REGION			
	Delhi			
1	Indian Institute of Technology, New Delhi	Central govt	5	HS or equivalent
2	Delhi College of Engineering, Delhi Delhi University	State govt	4	10+2 of CBSE
3	School of Planning & Architecture, New Delhi	Central	5	10+2 of CBSE
4	Dept of Technology, Jamia Millia Rural Instt. Delhi		4	Diploma in civil engg
	Jammu & Kashmir			
5	Regional Engineering College, Srinagar Kashmir Univ.	Central & State	5	PUC
	Chandigarh			
6	Chandigarh College of Architecture, Chandigarh Punjab Univ.	State	5	HS
7	Punjab Engg College, Chandigarh Punjab Univ.	University	4½	Production engg.
			4	Other courses.
8	Dept of Chemical Engg & Technology, Chandigarh Punjab Univ	University	4	PE or equiv
	Haryana			
9	Regional Engg College, Kurukshetra Kurukshetra Univ.	Central & State	5	HS/PUC
0	Technological Inst of Textile, Bhiwani Maharshi Dayanand Univ.	Non-govt	4	PE
	Punjab			
1	Guru Nanak Engg College, Ludhiana Punjab Univ	Non-govt	4	PE/F Sc
2	Thapar College of Engg & Technology, Patiala Punjabi Univ.	Non-govt	4	PE
.3	College of Agricultural Engg, Ludhiana	University	4	PE
	Punjab Agri. Univ		5	PUC
	Rajasthan			
4	Malviya Regional Engg College, Jaipur Rajasthan Univ	Central & State	5	HS
5	Birla Inst of Technology & Science, Pilani	Autonomous	5	10+2 of CBSE
6	M.B.M. Engg College, Jodhpur Univ. of Jodhpur	University	5	HS
7	College of Technology & Agri Engg, Udaipur Udaipur Univ.	University	5	Secondary or equiv
	Uttar Pradesh			
8	Indian Institute of Technology, Kanpur	Autonomous	5	1st yr Inter
9	National Sugar Inst, Kanpur	Central	2½ (Sugar tech.) 1½ (Sugar engg.) 1 (Industrial fermentation & alcohol tech.)	BSc or a deg. in Engg Mech./elect. engg B.sc with experience in distillation or AMSI (Sugar tech.)
20	Madan Mohan Malviya Engg College, Gorakhpur Gorakhpur Univ.	State	4	Inter
21	B.B. Technological Inst, Kanpur Kanpur Univ.	State	4	I.Sc.
			3	B.Sc.
22	Govt. Central Textile Inst, Kanpur Kanpur Univ.	State	4	I.Sc.
23	Motilal Nehru Regional Engg College, Allahabad Univ. of Allahabad	Central & State	4	I.Sc
24	University of Roorkee, Roorkee	University	5	Inter
25	Institute of Technology, Banaras Hindu University, Banaras	University	5	B Tech Engg
26	Zakir Husain College of Engg & Technology, Aligarh	University	5	B.Sc Engg after PUC
	Aligarh Muslim University		3½	Dip. in appropriate branch
27	Pant College of Technology Pant Nagar, U.P. Agricultural Univ.	University	4	B Tech. after I.Sc
28	Allahabad Agricultural Inst, Allahabad, Allahabad Univ.	Non-govt	4	Intermediate
29	D.E.I. Engg College, Dayalbagh, Agra Agra Univ.	Non-govt	4	I.Sc.
30	Kamla Nehru Inst. of Science & Technology, Sultanpur Awadh Univ.	Non-govt	4	I.Sc.
31	Dept of Electronics & Communication, J.K. Inst. of Applied Physics & Technology, Allahabad, Allahabad Univ.	University	3	B.Sc. HS(+2) JEE
	EASTERN			
	West Bengal			
32	Indian Institute of Technology, Kharagpur	Autonomous	5	HS(+2)
33	Regional Engg College, Durgapur Burdwan Univ.	Central & State	4	"
34	Faculty of Engg & Technology, Jadavpur, Calcutta Jadavpur Univ.	University	4 (engg. courses)	HS (+2)
			4½ Architecture)	
			3 Technical course	B.Sc. (Hons)
			4 (Part-time degree courses)	Diploma holders
35	Bengal Engg College, Sibpore, Howrah Calcutta Univ.	State	4	
36	Jalpaiguri Govt Engg College, Jalpaiguri North Bengal Univ.	State	4	
37	Dept. of Applied Chemistry, University College of Technology, Calcutta Univ.	University	3	B.Sc. (Hons in chemistry)

38	Dept. of Applied Physics, University College of Technology, Calcutta Univ.	"	3	B.Sc. (Hons) in physics
39	Inst. of Radio Physics & Electronics. University College of Tech. Calcutta Univ.	"	3	B.Sc (Hons) in phy or maths
40	College of Textile Technology, Serampore (Hooghly), Calcutta Univ.	State	4	HS JEE
41	College of Textile Technology, Berhampore (Murshidabad), Calcutta Univ.	State	4	"
42	College of Leather Technology, Calcutta Calcutta Univ.	State	4	"
43	College of Ceramic Technology. Calcutta Calcutta Univ.	State	4	"
44	Bihar Institute of Technology, Sindri Ranchi Univ.	State	4 4½	I.Sc. "
45	Bihar College of Engg., Patna Patna Univ.	University	4	I.Sc JEE for 50% seats. 50% seats for students, Patna Univ
46	Muzaffarpur Inst. of Technology, Muzaffarpur Bihar Univ.	State	4	I.Sc
47	Bhagalpur College of Engg. Bhagalpur	State	4	I.Sc. JEE
48	Regional Inst. of Technology, Jamshedpur Ranchi University.	Central & State	4	I.Sc. Ad. test for Bihar students
49	Birla Institute of Technology, Mesra, Ranchi Ranchi Univ.	Autonomous	4	I.Sc. Ent exam
50	Indian School of Mines, Dhanbad Deemed University	"	5 3	H.S. PUC Ent. exam. BSc (geology and maths)
	Orissa			
51	Regional Engg College, Rourkela Sambalpur Univ.	Central & State	4	PUC JEE for Orissa students
52	University College of Engg. Burla, Sambalpur Univ.	University	4	I.Sc Ent exam
	Assam			
53	Assam Engg College, Gauhati Gauhati Univ.	State	4	PUC/HS
54	Jorhat Engg College, Jorhat Dibrugarh Univ	State	4	HS ent
55	Regional Engg College, Silchar Gauhati Univ.	Central & State	4	HS/PUC
	Tripura			
56	Tripura Engg College, Barjala Calcutta Univ.	State	4	HS
	WESTERN			
	Maharashtra			
57	Indian Instt of Technology, Powai, Bombay	Autonomous	4	HS
58	Visvesvaraya Regional College of Engg, Nagpur	"	4 5 (Architecture)	HS
59	College of Engg, Gadge Nagar, Amravati Nagpur Univ.	State	4	HS
60	College of Engg, Osmanpura, Aurangabad Marathwada Univ.	"	4	F.Y./B.S
61	College of Engg, Karad Shivaji Univ.	"	4	Pre-prof HS/I.Sc
62	College of Engg, Pune Pune Univ.	"	4 3 (Degree in instrumentation, automatic control) 4½ (Sandwich course)	Pre-prof B.Sc. wi chem, p maths,5
63	Dept. of Chemical Technology, Bombay Bombay Univ.	University	4 3	HS IInd Cla B.Sc. (c phy, & botany)
64	Laxminarayan Inst. of Technology, Nagpur Nagpur Univ.	University	4 3	HS/F.Y. B Sc. (c phy/mat
65	Sir J.J. College of Architecture, Dr. D. N. Road, Bombay Bombay Univ.	University	10 semesters	HS & aptitude
66	Sardar Patel College of Engg, Andheri, Bombay Bombay Univ.	Non-govt	4	HS/I.Sc.
67	Victoria Jubilee Tech. Institute, Matunga, Bombay Univ.	Non-govt	4	HS/I.Sc
68	Walchand College of Engg. Vishram Bag, Sangli Shivaji Univ.	Non-govt	4	Pre-pro
	Gujarat			
69	Birla Vishwakarma Mahavidyalaya, PO Vallabh Vidyanagar, Kaira Distt Sardar Patel Univ.	Non-govt	4	Pre-sc. S. P. Un equiv.
70	Faculty of Technology and Engg., M. S. University, Baroda. M. S Univ.	University	5 (Architecture) 4 (Textile) 5 (Sandwich course) 3 B Sc (post B Sc phy Deg in Elect) 3 (Text chem) 4 (Part-time degree course)	HS " (Maths with 55 marks) B.Sc (p 55% ma Diplom 2 yrs ex
71	L. D. College of Engg, Navrangpura, Ahmedabad Gujarat Univ.	State	4 (Engg courses) 4 (part-time deg. courses)	F.Y.B.S (55%) IInd cla with 2 y exp.

72	Lukdhirji Engg College, Morvi, Saurashtra Univ	State	4	HS
73	S. V. Regional College of Engg & Technology, Surat South Gujarat Univ	Central & State	4	HS F.Y. B.Sc
74	Dharmasinh Desai Inst of Technology, Nadiad Gujarat Univ	Non govt	4	HS
75	School of Architecture, Navrangpura, Ahmedabad Cujarat Univ	"	5½	HS
	Madhya Pradesh			
76	Maulana Azad College of Technology, Bhopal Bhopal Univ	Autonomous	5	HS
7	Govt. Engg College, Bilaspur Ravishankar Univ	State	5	HS
8	Govt. Engg College, Jabalpur Univ. of Jabalpur	State	5	HS
			4 (Part time)	Diploma (55%)
9	Govt. Engg College, Rewa Awadesh Pratap Univ	State	5	HS
10	Govt. College of Engg & Technology, Raipur Ravishankar Univ.	State	5	HS
11	Govt. Engg College, Ujjain Vikram Univ	State	5	HS
2	Shri G. S Inst of Technology & Science, Indore Indore Univ	Non-govt	5	HS
			4 Part-time course	Diploma (50%)
3	Madhav Inst. of Tech. & Science, Gwalior Jiwaji Univ.	Non-govt	5	HS
4	Samrat Ashok Technological Inst., Vidisha Bhopal Univ	Non-govt	5	HS
	Goa, Daman and Diu			
5	Goa College of Engg, Fermagudi, Goa Bombay Univ.	State	4	Pre-prof/ HS
	SOUTHERN			
	Andhra Pradesh			
6	College of Engg. Kakinada, Hyderabad Jawaharlal Nehru Tech Univ	University	4	Inter
			4 (Part time)	Diploma
7	College of Engg, Anantapur Jawaharlal Nehru Tech Univ	University	4	Inter
			4 (Part-time)	Diploma
1	College of Fine Arts & Architecture, Hyderabad Jawaharlal Nehru Tech Univ	University	5	Inter, SSC/merit
)	Nagarjunasagar Engg College, Hyderabad, Jawaharlal Nehru Tech Univ	University	4	PUC
			4 (part time)	Diploma
)	Univ. College of Engg, Hyderabad Osmania Univ	University	4	Inter or equiv
	Univ. College of Tech, Hyderabad Osmania Univ	University	4	Inter
	College of Engg, Waltair Andhra Univ.	"	4	PUC/HSC/ Inter
			4 (Part-time)	Diploma
	Andhra Univ. College of Science & Tech, Waltair Andhra Univ	"	4	PUC/HSC/ Inter
94	Sri Venkateshwara Univ College of Engg, Tirupati S. V. Univ.	"	4	Inter
95	Sidhartha Engg College, Vijayawada Nagarjuna Univ.	Non-govt	4	Inter
96	Chaitanya Bharathi Inst. of Technology, Hyderabad Osmania Univ.	Non-govt	4	Inter
97	N. B. K. R. Inst of Science & Techn., Vidyanagar Sri Venkateshwara Univ.	"	4	Inter
98	Sagi Ramakrishnan Raju Engg College, Bhimavaram Andhra Univ.	"	4	Inter
99	K. S. R. Memorial Engg College, Cuddapah S V. Univ	Non-govt	4	Inter
100	College of Engg, Machilipatnam Andhra Univ	"	4	Inter
101	Kakatiya Inst. of Tech. & Science, Warangal Kakatiya Univ.	"	4	Inter
102	Sultan-ul-uloom Education Society's College of Engg & Technology, Hyderabad Osmania Univ	"	4	Inter
103	Gandhi Inst of Tech. & Management, Visakhapatnam Andhra Univ	"	4	Inter
104	Regional Engg College, Warangal Kakatiya Univ	Autonomous	4	Inter
			4	Diploma (2 yrs exp)
	Karnataka			
105	Govt. B. D T College of Engg, Davangere Mysore Univ	Govt	4	2-year PUC
106	Govt Sri Krishnarajendra Silver Jubilee Tech Inst, Bangalore Bangalore Univ	Govt	4	"
107	University Visvesvarya College of Engg, Bangalore Bangalore Univ	University	4	"
108	B M S. College of Engg, Bangalore Bangalore Univ	Non-govt	4	"
			4 (Part-time)	Diploma (3 yrs exp
109	National Inst of Engg, Mysore Mysore Univ	"	4	2-year PU
110	B V B College of Engg & Technology, Hubli Karnataka Univ	"	4	"
11	Manipal Inst of Tech, Manipal, Udupi Mangalore Univ	"	4	"
112	H K.E. Society Engg College, Gulbarga Karnataka Univ	Non-govt	4	"
113	Malnad College of Engg, Hassan Mysore Univ	"	4	"
114	P E.S College of Engg, Mandya Mysore Univ	"	4	"
115	M. S. Ramaiah Inst. of Technology Bangalore Bangalore Univ.	"	4	"



16 R.V. College of Engg. Bangalore, Bangalore Univ.	"	4	"
17 Sri Siddaganga Inst. of Technology, Tumkur Bangalore Univ.	"	4	"
118 Sri Jayachamarajendra College of Engg, Mysore Mysore Univ.	"	4	"
119 Basaveshwar Engg College, Bagalkot Karnataka Univ.	"	4	"
120 Dayananda Sagar College of Engg, Bangalore Bangalore Univ.	Non-govt	4	"
121 Bangalore Inst of Tech, Bangalore Bangalore Univ.	"	4	"
122 Islamiah Inst of Tech, Bangalore Bangalore Univ	"	4	"
123 Bapuji Inst. of Engg & Technology, Davangere Mysore Univ	"	4	"
124 Sri Dharmasthala Manjunatheshwara College of Engg & Tech, Dharwad Karnataka Univ.	"	4	"
125 Ghousia College of Engg. Ramanagram Bangalore Univ.	"	4	"
126 Adi Chunchanagiri Inst of Technology, Chikmagalur Mysore Univ	"	4	"
127 K.L.E Society's Engg College, Belgaum Karnataka Univ.	"	4	"
128 H.K.E. Society's Engg College, Raichur Karnataka Univ	Non-govt	4	"
129 Karnatak Law Society's Engg College, Belgaum Karnataka Univ.	"	4	"
130 Jawaharlal Nehru National College of Engg, Shimoga Mysore Univ.	"	4	"
131 Guru Nanak Dev Engg College, Bidar Gulbarga Univ.	"	4	"
132 Anjuman Engg College, Bhatkal Karnataka Univ.	"	4	"
133 Sri Siddhartha Inst of Technology, Tumkur Dist. Bangalore Univ	"	4	"
134 Khaja Banda Nawaz College of Engg, Gulbarga Gulbarga Univ	"	4	"
135 B.L.D.E. Association's College of Engg & Tech, Bijapur Karnataka Univ.	"	4	"
136 Murugharajendra Inst. of Technology, Chitradurga Mysore Univ.	"	4	"
137 Vijayanagar Engg College, Bellary	"	4	"
138 Rural Technical Education Society Engg College, Hulhoti Karnataka Univ.	"	4	"
139 S.T.J.E. Engg College, Rane Bennur Karnataka Univ.	"	4	"
140 Indian Inst. of Science, Bangalore	Autonomous	3	IInd Class B.Sc.

141 Karnataka Regional Engg. College, Surathkal, Mangalore	"	4	2-year PUC
Kerala			
142 College of Engg, Trivandrum Kerala Univ.	Govt	4 4(part-time)	PD Dip with 2 y
143 Govt. Engg College, Trichur Calicut Univ.	"	4 4 (Part-time)	PD Dip. with yrs exp.
144 T K M. College of Engg, Quilon, Kerala Univ	Non-govt	4	PD
145 N S.S College of Engg, Palghat, Calicut Univ.	"	4	PD
146 Mar Athanasius College of Engg, Kothamangalam Kerala Univ.	"	4	PD
147 Regional Engg College, Calicut, Calicut Univ	Autonomous	4	PD
Tamil Nadu			
148 Govt College of Tech, Coimbatore Madras Univ	Govt.	4 3½ (part-time)	PUC/HS Dip (3
149 Govt. College of Engg, Salem Madras Univ.	"	4 3½ (Part-time)	HS/PUC Dip with 3 yrs exp.
150 A.C. College of Engg and Technology, Karaikudi Madurai Kamaraj Univ.	"	4 3½ (Part-time)	HS/P Dip with 3 y exp.
151 A.C College of Tech, Madras Anna Univ.	University	4	HS/PUC
152 Faculty of Engg & Technology, Annamalai Nagar Annamalai Univ.	"	4 3½ (Part-time)	HS/PUC (6 Dip with 3 y exp.
153 Department of Tech Annamalai Nagar Annamalai Univ.	"	4	PUC/HS
154 College of Engg, Madras Anna Univ.	"	4 3½ (part-time)	HS/PUC (6 Dip with 3 exp.
155 Madras Inst. of Tech, Madras Anna Univ	"	3	B Sc (60%
156 School of Architecture and Planning, Madras Anna Univ	"	5	HS/PUC maths
157 P S.C College of Tech, Coimbatore Madras Univ.	Non-govt	4 3½ (Part time) 3 yrs	HS/PUC L.T M / D T 3 yrs exp. D M E / D 3 yrs exp
158 Coimbatore Inst of Tech, Coimbatore Madras Univ	"	5 3½ (Part-time)	HS/PTC/PUC Dip with 3 y exp.
159 Thiagarajar College of Engg, Madurai Madurai Kamaraj Univ	"	4 3½ (Part-time)	HS/PUC/PTC Dip with 3 y exp.
160 Indian Inst. of Tech, Madras	Autonomous	5	PUC/HS
161 Regional Engg College, Trichy.	"	4 3½ (art-time)	HS/PUC Dip with 3 y exp.

The list excludes two special institutions in West Bengal conducting courses in jute technology and marine engineering and three special institutions in Maharashtra conducting diploma courses equivalent to degree in G.D. Architecture for want of information.

TWO CHEERS FOR GENERAL RELATIVITY

Continued from p. 25

attempts at grand unification aim at unifying three of the four basic forces of nature, leaving apart (ironically) the force of gravity. For it is realised that gravity as presented through general relativity does not quite fit into the present scheme of unification. The present attempts at unification are nevertheless indirect tributes to Einstein's vision: for he embarked upon his unification work at a time when all other leading physicists were sceptical.

Two alternatives are thought of to remedy the situation. One is to construct a quantum theory of gravity, a task that is immensely difficult. The difficulty lies both in relativity and in quantum theory. Quantum theory describes the properties of nature at a very small (microscopic) level. Just as matter looks continuous and unbroken at the "everyday" macroscopic level but is in fact made of discrete particles like atoms and molecules, so it is with the general description of physics. For example, electromagnetic radiation appears to be a continuous flow of waves at the macroscopic level, but at the microscopic level it is also made of particles of light called "photons". Likewise physicists believe that gravitational radiation is made of "gravitons"—particles like photons. But remember, according to general relativity, gravity is a manifestation of spacetime geometry. So how do we stretch a geometrical meaning to the "graviton"? Does it imply that the spacetime structure is not continuous but is discrete? These questions are conceptually hard to answer. Just as at the classical level gravitational radiation proved to be much more complex in nature than electomagnetic radiation, so has quantum gravity turned out to be much more intractable than quantum electrodynamics But it is essential to quantise the general theory of relativity if gravity is to be united with other forces of nature.

Perhaps the difficulties of this path have prompted some physicists to take another route of *supergravity*. This is a new approach to gravity somewhat akin to the particle physicists' way of looking at basic interactions. It is too early to say whether this path will lead us to the desired goal.

To sum up then, we may judge the performance of general relativity to date on three criteria: (1) Did the theory introduce a dramatic input of new ideas into fundamental physics? (2) Has it passed all the possible experimental tests to date? (3) Has it interacted with other branches of physics to stimulate further advances? To me the answer is "yes" on the first two counts but "no" on the last.

I can therefore raise only two cheers for general relativity today

Prof. Narlikar, who heads the Theoretical Astrophysics Group at the Tata Institute of Fundamental Research, Bombay, is President of the Indian Association for General Relativity and Gravitation (1982 84)

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"To fight CANCER we will have

NOTWITHSTANDING the artificial boundaries that man creates between him and his neighbour, there are certain afflictions which threaten mankind as a whole. Cancer is one such danger confronting all of us. It is equally true, however, that there are organisations which transcend the divisive barriers and launch crusades against such threats. The International Association for Research in Cancer (IARC), with its headquarters at Lyons, France, is one such organisation dedicated to fight this scourge. If there is one individual who personifies this sense of dedication, this spirit of the crusade against cancer, then he is Lorenzo Tomatis. Prof. Tomatis has been with the IARC ever since its inception and today he is its Director-General.

Prof. Tomatis is diminutive only in his physical stature but a giant by way of his scientific contributions. For a Frenchman, he is uncharacteristically quiet, not given to any significant gesturing. His voice is soft, almost velvety. But that velvet acquires a hard steel lining when it comes to the subject of smoking. His hands suddenly become tellingly expressive—as if he cannot find adequately strong words to condemn this treacherous, deplorable habit of man responsible for inviting cancer. As a matter of fact, that is the theme he singularly projects: that man unwisely and irresponsibly subjects himself to unnecessary insults that provide the toe-hold for cancer. He has, therefore, made it his life mission to identify, and uncover all such factors responsible for promoting malignant growth which man himself in his wayward, errant manner lets loose. Be they in the form of an environmental pollutant, or a drug which does more harm than good, or a food item which might well be left alone or a food habit which should be broken, Prof. Tomatis has vowed to present man with weighty, incontrovertible evidence about their effects. Research in the aetiology of cancer according to him, should gain priority over treatment-modalities, for prevention is better than cure.

Prof. Tomatis was in India recently to inaugurate a symposium on Cancer Research and almost evangelically presented his massive evidence. SCIENCE TODAY took this opportunity to interview him and pose questions that you always wanted to ask yourself.

Do you think that the level of financial investments in cancer research, either at the International Association for Research in Cancer, (IARC), at Lyons, France or worldwide is adequate?

No. The amount of money spent is not enough, although I must confess that the absolute amount might appear as a decent one. I will give you an example. When the IARC was founded in 1965 in five countries namely, France, Italy, FRG, UK and USA, it was decided that 0.1 per cent of the respective country's defence expenditure will be allocated to cancer research. If that percentage were to be maintained, we should have had 200 million dollars from the US alone, whereas what is being spent is roughly 150 thousand dollars. If this sum appears fairly large, I would like to remind you that the lost earnings due to people dying from cancer was of the order of 40 billion dollars in 1983. Add to this the expenses on medical care, which is also of the same order. Interestingly, two companies in the US selling tobacco, spend on their advertising as much money as the National Cancer Institute, Maryland, USA, does on cancer research.

If enough money is not made available then surely cancer research must be affected?

Certainly. Now we do not have money to hire new people and younger talent or to extend our activities, which is absolutely essential.

Do you think that the cancer incidence in general is increasing?

Yes, absolutely so. It is not galloping away but the incidence is certainly increasing.

Does it mean that more people are dying of cancer today than before?

No. I am not saying that persons having cancer have high mortality. I am talking of absolute numbers affected by cancer. Today, because therapeutic regimen has improved we are able to cure more and more people.

Is it not good enough then?

No. Certainly not. There is no room for complacency, we must reduce mortality. I would give one instance. Smoking is very much on the increase, leading to lung cancer and many deaths—even in developing countries, where cancer incidence was low in earlier days.

Cancer is considered a geriatric disease, mostly affecting old people. Is it true?

Yes.

Why is it so?

Well, firstly there is an increase in life expectancy. Secondly, there is a drastic reduction of deaths at earlier age due to other diseases and risk factors. More importantly, there is a great expansion of risk factors which have proliferated due to extensive industrialisation, and continuous exposure to these factors (certain chemicals at home or in industries or excessive smoking for a long period of time) can result in cancer in the old age.

to control our environment"

—Prof. Tomatis

Would you then consider cancer as a cultural disease or a disease due to particular life-style?

It depends on what you call 'life-style'—smoking, drinking, eating, working? If some of these activities, for instance, smoking, increase the risk, it is a disease of the life-style. Socio-economic status also plays a role in causing cancer.

Like permissive living considered to be responsible for diseases, like AIDS?

Yes, the analogy is apt to the extent that cancer can be considered a disease due to life-style.

Is there any indication that there is a greater incidence of cancer in other age groups, also?

Not in a blanket manner. But for certain types of cancer, the incidence is increasing. For example, breast cancer and melanoma are increasingly found in younger age groups.

Melanoma is more of a problem in European countries and northern latitudes. What about tropical and sub-tropical countries?

There too it is increasing.

You have talked about the importance of aetiology of cancer, especially identifying chemicals which might cause cancer. Since it is not possible to do anything about these chemicals like removing their toxicity, what purpose is served by identifying more and more chemicals?

A good question. For example, it is true that vinyl chloride which was identified as a chemical carcinogen, has not been abandoned in industrial use, nor has its production been suspended; but its identification as a chemical carcinogen has certainly helped to reduce the risks associated with its use. Previously, large amounts were left lying around without any precautions. Now, measures are taken to reduce the risk-level which in turn increases the productivity also. And at the consumer end where the exposure is at a very low level, assessment of the risk can be undertaken and that is very important.

What's the role of nutrition in cancer incidence? I am asking this question particularly in view of protein-calorie malnutrition in India.

It is a very difficult question. Deficiency of certain micronutrients is known to enhance the carcinogenic risk factor Also, indirectly too cancer-risk is enhanced. For example, melanoma reduces immune defences which may also contribute to increase cancer incidence.

The recent discovery of oncogenes has given a feeling to the lay public that cancer is hereditary. Would you agree to this?

Prof. Tomatis with Dr. Phondke

No. On a hereditary basis, the cancer incidence are indeed rare. To get cancer, two elements are necessary—a carcinogen and an individual. What an oncogene indicates is only an innate susceptibility of the individual.

Does it mean that both oncogenes and certain promoters (cancer-inducing agents) should act in cohesion to give rise to cancer?

That's right If an oncogene is present, its activation would be more facile and then cancer will be caused. But an oncogene by itself does not indicate what factors can give rise to cancer

A great deal of cancer research is carried out in animals And, a considerable section of people feel that this is unnecessary and the animals are needlessly being tortured for experimentation. Would you agree?

Well, you should view this aspect in totality from the angle of all the uses of animals for research purposes. Only 10 per cent of these animals are used for biological research and cancer research utilises only a fraction of these. I agree that the major use of animals is not in constructive research—it is for cosmetic research where the animals are tortured, etc. In contrast, in cancer research the animals are maintained in good condition. The advances in different scientific disciplines further reduce their use to the absolute minimum. For example, more and more cell lines and prokaryotic systems are used for screening chemicals. One should not forget that human experimentation is even worse and the use of animals, of course, should be on a very selective basis and to the minimum extent—all for a better human life

In the management of cancer, what priorities would you set for the future?

As you know, right from the beginning a multi-pronged strategy has been employed to tackle the cancer problem. And this should continue. Laboratories have been set up to study its aetiology, epidemiology, chemotherapy and immunology. Attempts have been made to quantify the risks of various carcinogenic agents, including certain dietary habits and identify individual susceptibilities. Now, the stress is on using monoclonal antibodies for the fight against cancer.

Since cancer is considered as a disease of the old, certain sections view all the money and research effort as misdirected and going waste. Would you comment on this?

This sort of thinking is really unfortunate and sad It's a different thing that governments don't want to spend increasing amounts on cancer research and hence the research returns are bound to be diminished But that does not justify the thinking that senior citizens are a drain on society. It is tantamount to saying that these same people will be happy if the different governments can fund cancer research to kill the old at 71. The primary aim of all medical research programmes should be health preservation and keeping the old people healthy so that they can prove themselves to be useful members of society. □

BUILDING UP AN IMAGE

S. Arun-Kumar **R. Chandrasekhar** **Kamal Lodaya** **Paritosh Pandya** **R. Ramanujam**

THE computer, we know, processes numbers but it can be made to process data in other forms as well; for example, letters, words or any other symbols. For this, the computer has to be taught to recognise the symbols which implies that symbols have to be encoded into numeric form. Once it is done we can work directly with symbols themselves. Such symbol processing is the basis of all modern applications of the computer.

Symbol processing

A good example of symbol processing, with a wide range of applicability, is the manipulation of polynomials occurring in algebraic calculations.

Almost always a problem is stated in terms of variables—say, x and y. Let us suppose it is required to multiply two polynomials expressed in terms of these. The multiplication can be performed using simple rules of algebra and numerical values can be assigned to the unknown quantities in the end to get the final answer.

Consider the simple multiplication given below, with $x = 6$.

$$(x + 3)(x - 3) = x^2 + 3x - 3x - 9$$
$$= x^2 - 9 = 36 - 9 = 27$$

Why go through this convoluted series of operations? Why not simply substitute the values and perform the operations on the numbers themselves?

$$(x + 3)(x - 3) = (6 + 3)(6 - 3) = 27$$

There are many advantages of doing algebraic manipulations before plugging in the numerical values, especially when the calculations are lengthy.

Algebraic formulae appear in a wide variety of situations. For example, x and y could represent current and voltage in an electrical problem or time and distance in a mechanical problem. Simplifications of the formulae with a set of rules could yield a simplified form, applicable in either case. Frequently this results in the saving of computer time.

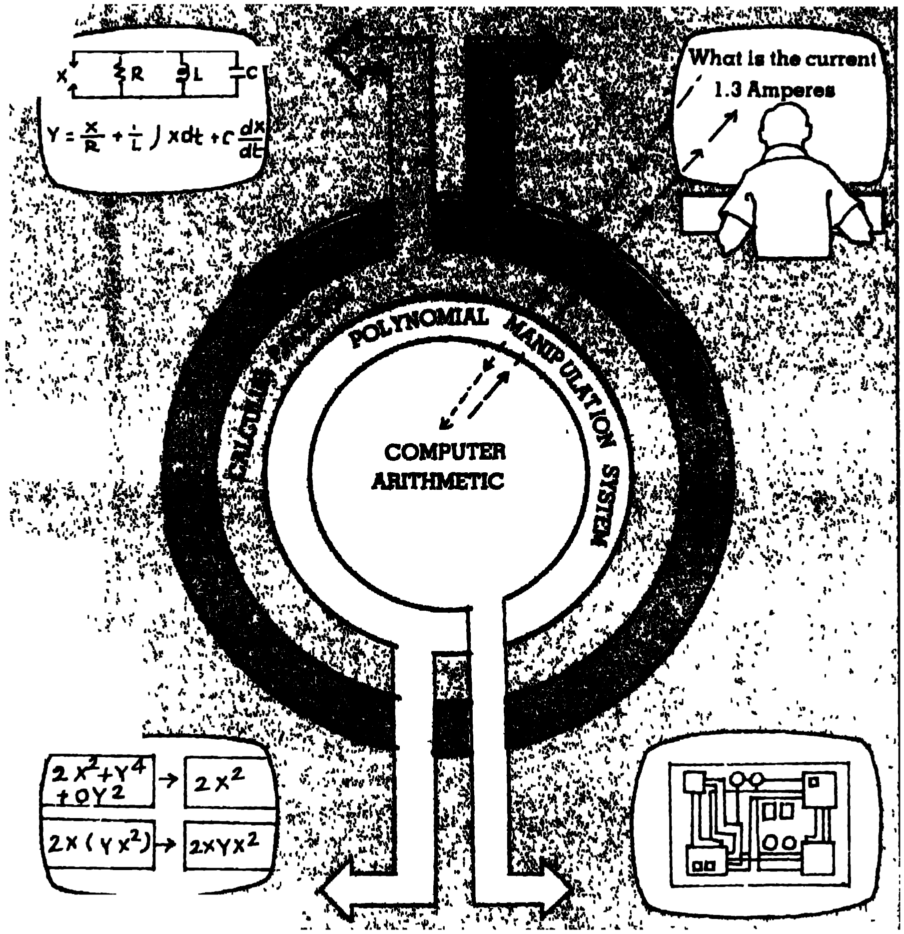


Fig. 1 Symbol processing shells

The essential steps in symbol processing consist of:

☐ Recognising the fundamental entities and the operations to be carried over them

☐ Representing the new symbols in terms of those already available on the computer

☐ Programming the operations on each new symbol in terms of the operations already available

☐ Programming the application in terms of the new symbols and their operations

In the above example the fundamental entity involved is the polynomial. How do we represent this in the computer? Before we answer this, note that the same polynomial can be represented in various ways.

$0x^3 + x^2 - 9$, $3x^2 - 2x^2 + (-9)$, $x^2 - 9 + 3x - 3x$, $(x + 3)(x - 3)$

We can adopt a standard form, $1x^2 + 0x - 9$ for this polynomial.

We then represent it by a listing of numbers [1, 0, 9]. Similarly, [5, −1, 2, −3, 0] can stand for $5x^4 - x^3 + 2x^2 - 3x$. The reader will probably enjoy handling the problem of more than one variable (Hint: encode the variables as well).

Then we have to decide how to input the polynomials and what sort of an output we want. That is, the representation has to be not only machine—readable but also human—perceivable.

After this, we programme the addition, subtraction and multiplication of polynomials in terms of our lists of

The computer has become more widely accessible, making symbol processing meaningful for many more purposes

numbers. In fact, more operations have to be included if found necessary.

We have built successfully, a sort of *shell* around the computer. Now we can pretend that the computer understands polynomials. Our further applications can be planned starting with this assumption.

There is no reason why another shell cannot be built over this one! Figure 1 demonstrates one such hierarchy of shells developed in the early sixties for the benefit of electrical engineers, interested in designing circuits. Using the top level capability, the engineer could ask questions like:

What is the current across the 5K resistor if a 1μF capacitor is addded in parallel to the 10V source?

Of course, that can't be asked in plain English, but in a language specially designed for the program. A more complicated, but still routine, query would be:

Find the optimum value of an inductance at a given point in a network.

This is a typical computer application for an expert, since it requires highly specific knowledge about the problem-solving domain. We will look at other such expert systems a little later.

Word processor

The above example was somewhat mathematical in nature. In fact, early symbol processing applications on the computer were for the benefit of mathematicians and scientists. In recent years, however, the computer has become more widely accessible, making symbol processing meaningful for many more purposes.

As we have pointed out in an earlier article, the development of writing permitted the storage of information in the form of text (printing made it more permanent). For almost any transaction, we keep a written record. Moreover, most of our heritage is enshrined in the form of texts, be it prose or poetry, in English or in Sanskrit. Can the computer be made to process text?

What are the operations that can be performed on text? Consider the very

> You see, I had decided—rightly or wrongly—to grow a moustache, and this had cut Jeeves to the quick. He couldn't stick the thing at any price, and I had been living ever since in an atmosphere of bally disapproval till I was jolly well fed up with it. What I mean is. While there's no doubt that in certain matters of dress Jeeves's judgement is absolutely sound and should be followed, it seemed to me that it was getting a bit too thick if he was going to edit my face as well as my costume.

Fig. 2 Text before justification

> You see, I had decided—rightly or wrongly—to grow a moustache, and this had cut Jeeves to the quick. He couldn't stick the thing at any price, and I had been living ever since in an atmosphere of bally disapproval till I was jolly well fed up with it. What I mean is. While there's no doubt that in certain matters of dress Jeeves's judgement is absolutely sound and should be followed, it seemed to me that it was getting a bit too thick if he was going to edit my face as well as my costume.

Fig. 3 Text after justification

process of preparing a neat write-up (maybe an office memo or a Ph.D. thesis). We start with a draft and invariably make changes and corrections before getting it in the final form. To program this application, writing means inputting it into the computer, and reading means asking the computer for a display. But correction means changing the text Typical corrections are of the type:

- ☐ Spelling mistakes.
- ☐ Inserting, replacing and removing words.
- ☐ Moving sentences (even paragraphs) around.

A text is a list of sentences, a sentence is a list of words, a word is a list of characters, and characters can be encoded into numeric form. We can also have higher subdivisions like paragraphs or chapters The operations required over *each* of these symbols are insertion *and* removal (replacement is just a removal followed by an insertion).

In practice, it is not so easy to handle these units (is punctuation part of a word, for example?). So **text editors** —the programs which cater to such manipulation— normally have operations on characters, lines and pages They also make it possible to quickly browse through the material to search for a particular portion of the text, with the help of a special command.

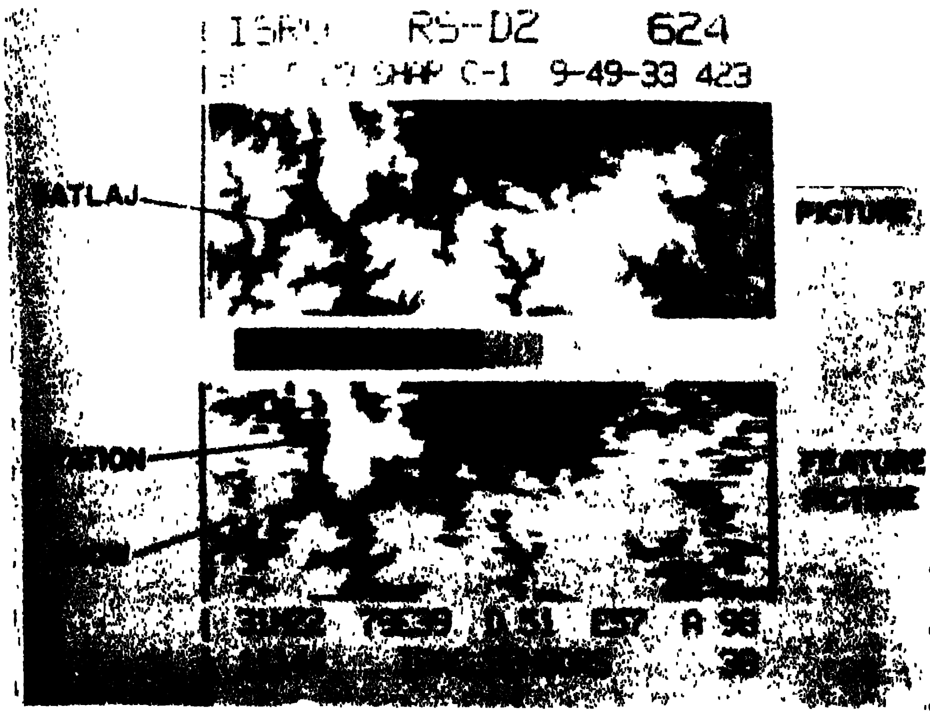
The "neat write-up" is printed by another program, called a **text formatter.** Consider the text shown in Figure 2, which is roughly as a typist would enter it. It can, however, be neatly aligned to look like Figure 3. Most people would agree that the latter looks much better It is, in fact, ideal for the multi-column format of a newspaper or magazine Such alignment, called **Justification,** has traditionally been performed by a *typesetter*, but a computer program can do it as well.

It is slightly tricky to define the rules for justification, especially if hyphenation is also to be performed. The rules tend to be somewhat *adhoc*, and depend upon the taste of the typesetter. When is some justification good? When is one hyphenation *uglier* than another? These are difficult things to make one understand and more so with a computer! One possible solution is to say that the total amount of blank space in a paragraph must be as evenly distributed as possible. Once such rules are stated, a program can perform the layout as well as an expert typesetter.

Formatting can be done for output to a typewriter or a phototypesetter in a printing press. The program will vary, since the press allows much greater flexibility than the typewriter, the most noticeable being the availability of several fonts of type

Word processors are computers that have such programs to manipulate text One can give a simple command, for example, to format a story in three 3 inch columns with a page size of 50 lines Attempts are also being made to automate the proper placement of figures in a text.

Experimenters wanted a plot of their results, social scientists, maps and managers, bar charts



Courtsey Current Science

Fig. 4 Image enhancement of a satellite picture

Processing pictures

As the use of computer spread, it became evident that numbers (and text) were not always the most desirable form of output. Experimenters wanted a plot of their results, social scientists, maps and managers, bar charts. For example, an astrophysicist would prefer a graph showing regions with a high concentration of hydrogen to a huge mass of numbers from which he has to pick out the relevant points.

Computer graphics developed precisely to fulfil this need initially with the help of plotters, and gradually moving on to today's colour video terminals. But graphics is not merely a matter of adding new hardware. The representation and manipulation of pictures in terms of existing computer symbols is a major headache. In order that the visual representation be faithful to the original, the display must have a high resolution (more dots per unit area). A screenful of data works out to tens and thousands of dots, and continually updating—sometimes even displaying—this data requires a lot of computing power.

In **image processing** the computer is used to transform a picture into a more comprehensible one. One of the popular techniques is to remove grey tones, converting grey to black or white depending on the surrounding context. This increases the contrast, making the picture much sharper (Fig. 4). Another technique is to accentuate certain parts of the picture with (false) colours. For example, the astrophysicist may want particular regions of the galaxy marked out in red.

Although it seems to be the most natural thing for us to look at a picture and recognise the various shapes and shades in it, a tremendous amount of processing by the eye and the brain is involved in this.

Pattern recognition tackles this problem and is put to as varied applications as reading cheques, medical diagnosis from radiographs and analysis of nuclear bubble chamber pictures.

Process control

A minicomputer or a microprocessor can be made an integral part of an instrument to make the instrument more powerful and also versatile. For example, a microcomputer tied to a measuring instrument can take measurements automatically according to a prescribed schedule, correct for errors in the measuring device, process the information obtained and finally display them on a screen or print them out. By making changes in the program, the same instrument can be used for altogether different types of measurements. With the low price of microprocessors — 8 bit chips are placed below $10—there is no reason for not using them.

Such considerations have led to the use of computers in process control. The fundamental quantity in these applications is an *event*. This being somewhat a novel concept, we illustrate with an example. Consider the operation of an automatic lift. The lift has to manage calls to it by people from various floors as well as from passengers inside the lift, and in accordance with its current direction of movement decide the correct order in which to take the calls. Another detail to be taken care of is the opening and closing of doors.

Every time someone interacts with the lift, an event takes place and is recorded. The lift's future operation is based on these events. Some events may require real time action: for example, pressing the emergency stop button should result in an immediate halt and opening of doors (and also ring an alarm). Such event-based action is typical of process control applications.

It might seem that this would hardly require a computer. But suppose you have more than one lift, and all the lifts are required to operate in the most energy-efficient manner! This vividly demonstrates the flexibility underlying a programmed controller—it can tack-

We are living through an information revolution that will have far reaching consequences on our lives

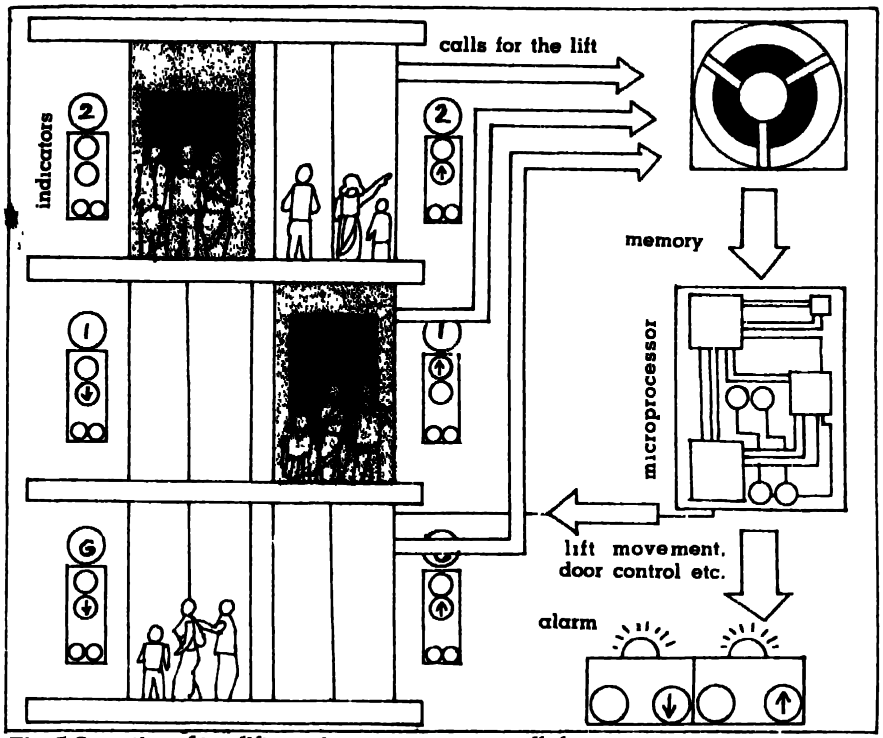


Fig. 5 Operation of two lifts—microprocessor controlled

le new situations and can be made as sophisticated as required.

(Surprisingly enough, computer science has benefited from lifts as well. The "elevator algorithm" is also used to operate many disk heads that are reading and writing on a disk.)

The information revolution

We have looked at computers from two different angles: their historical development and their various applications. It is now appropriate to look at them in a more global context.

It is almost always the case that a new invention is built for a specific purpose at an enormous cost, and only a specialist can use it. But if the invention is truly versatile, its use spreads and it becomes general-purpose, cheap and easy to use. The clock, for instance, was originally developed for sailors and navigators. But the convenience of knowing the time of day accurately was so attractive that it was soon catering to more general use. The electric motor is another outstanding example.

The same is the story with the computer. At first, it moved from being a *research* tool to a *developmental* one. The next step, of course, was *production*, but that required the tool to be economical. The development of the microcomputer, and more so, of the microprocessor made such economy possible.

Today **personal computers** (or PCs as they are popularly called) are making their presence felt in almost all areas of life—business, science, education and home.

Most of the home computers, though being used mainly for recreational purposes, could also serve as word processors, educational aids and personal accounting tools. Their more novel applications include electronic mail and information directories.

PCs are a new phenomenon, and it is somewhat premature to judge their impact yet. But one thing is quite certain: we are living through an information revolution that will have far-reaching consequences on our lives. □

The authors are Visiting Scientists at the National Centre for Software Development and Computing Techniques (NCSDCT) Tata Institute of Fundamental Research, Bombay

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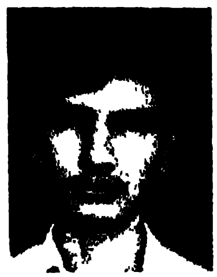
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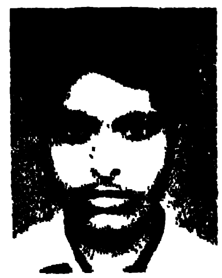
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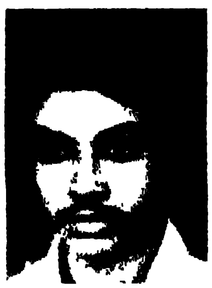
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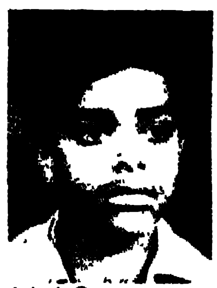
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Radical

RINGINGTONE SYNTHESISER

AT the Broadway theatre, New York, in the US, one of the prestigious 'Tony Awards' was bagged by an electronics engineer who programmed computerised light-effects for a famous play 'Amadeus'. This shows that stage craft has now been developed into a very sophisticated technique where modern tools such as microprocessors and computers have made their impact.

In many modern plays, the telephone has become a common feature on the stage. The amateur as well as professional performers usually depend on the electrical or mechanical bell for creating the effect of incoming calls on the stage. Apart from the fact that this method fails to create an impression of the authentic sound of the telephone bell, the little lapse on the part of the technician handling the bell can lead to an embarrassing situation such as, for example, the continuous ringing of the bell even after the hand-set of the telephone is lifted. The circuit described here enables one to create the genuine effect of the telephone ringing as well as helps avoid any possible lapses. The set-up can also be useful in television and cine-studios.

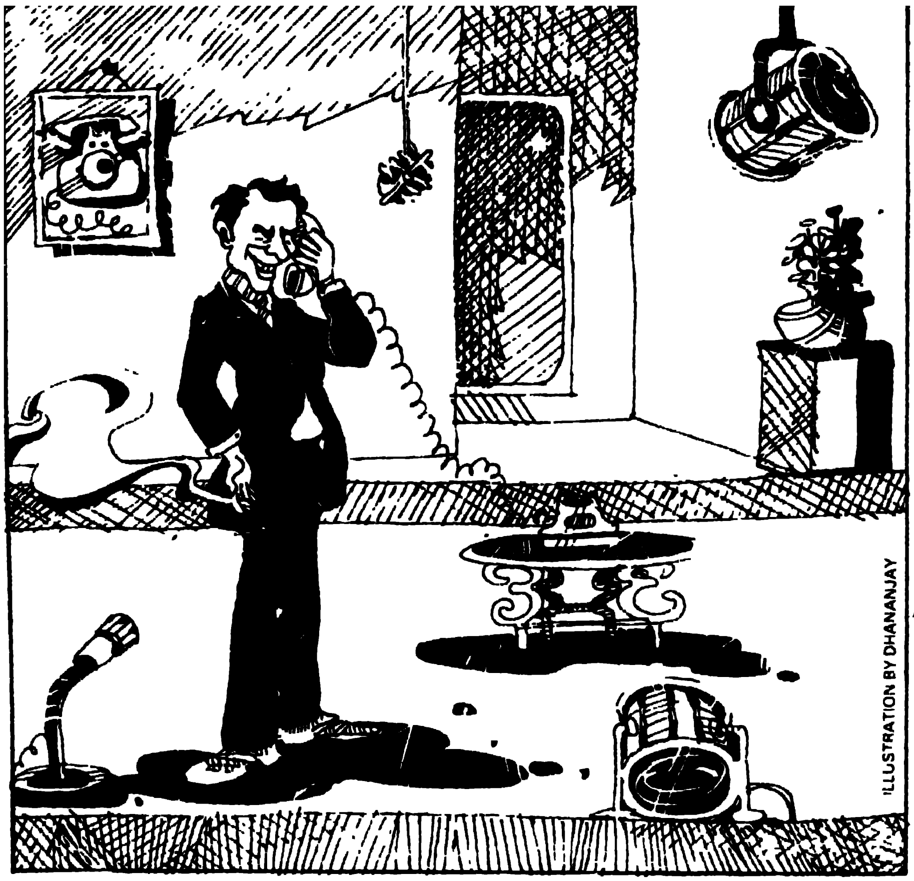
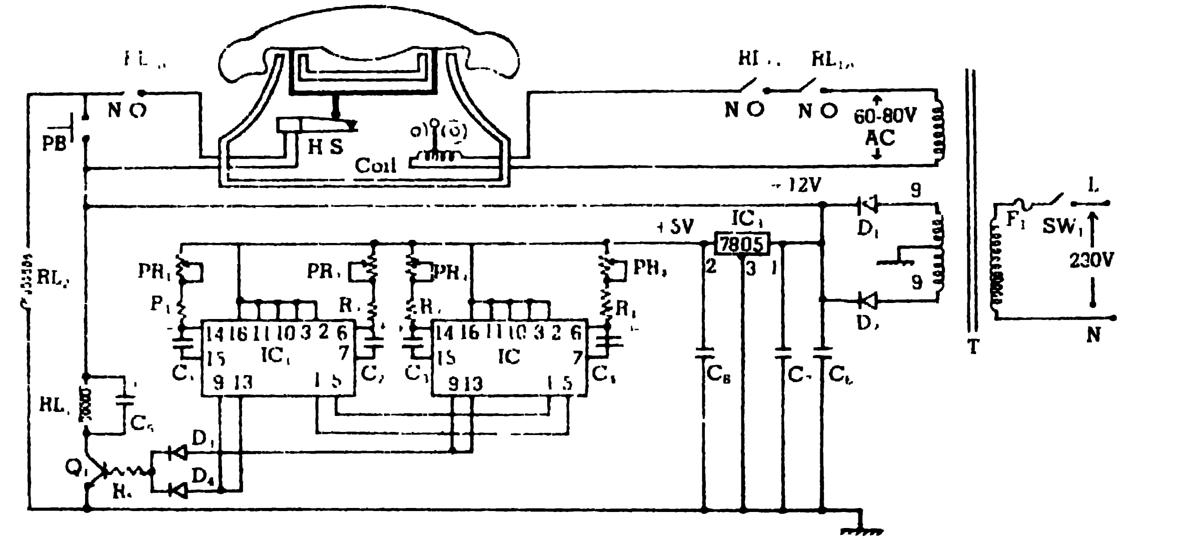


ILLUSTRATION BY DHANANJAY

Circuit and its operation

The step-down transformer has two secondary windings, one for 60-80V AC supply for the bell-coil, and the other for 12V full-wave rectified DC supply (shown in Fig. 1). The IC_3 is a voltage regulator and provides +5V supply to IC_1 and IC_2. The +12V supply is used for relays RL_1 and RL_2. Fig. 2 indicates the timing cycle for the ring-tone in a telephone. This cycle is generated in the circuit by using dual timers IC_1 and IC_2, which provide four timer-blocks for generating time delays T_1, T_2, T_3 and T_4. In a given configuration of R_x, PR_x and C_x, these time delays are governed by the equation, $T_x = 0.28\ C_x\ (R_x + PR_x)$ where T_x, C_x are expressed in nanoseconds and picofarads, respectively, while R_x and

Fig. 1

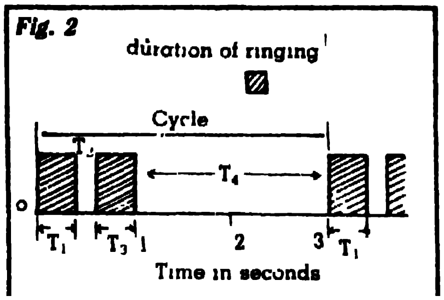


The authentic sounding of the telephone bell on the stage can avoid embarrassing situations such as, continuous ringing even after the hand-set of the telephone is lifted

PR_x are in kilo-ohms. The time delays T_1 and T_2 are realised in IC_1, and T_3 and T_4 in IC_2. Timer-blocks for time delays T_1 to T_4, can be designated as t_1 to t_4 respectively. The output of t_1 drives the trigger input of t_2, the output of which drives, in turn, the trigger input of t_3. This continues till the loop is completed by triggering the input of t_1 by the output of t_4. The telephone bell rings during delays T_1 and T_3 only. Hence, the outputs of t_1 and t_3 are 'OR'ed by using two diodes, which energise relay RL_1 via Q_1. In this condition, if RL_{2B} contacts are also closed the 60-80V AC will be connected to the bell-coil during T_1 and T_3. This can be done by pressing the push-button (PB situated off the stage) which latches RL_2 via RL_{2B}, provided that HS contacts are closed (that is, the hand-set is on the cradle). Once the relay RL_2 is latched, the telephone bell starts ringing as dictated by the sequence-generator, through RL_{1A} contacts. The ringing tone sequence continues till the hand-set is lifted (that is, HS contacts are opened and RL_2 unlatched). The setting of the time delays T_1, T_2, T_3 and T_4 in a cycle can be done by presetting the potentiometers PR_1, PR_2, PR_3 and PR_4 respectively as desired. However, the optimum values for these time delays are given in Fig 2.

Occasionally, the accidental misplacement of the hand-set on the cradle, after receiving a call by an actor on the stage, can leave the HS contacts open and can create a problem in latching the sequence-generator in the subsequent operation through PB. To circumvent such accidental situations an additional facility in the latching circuit is incorporated. In case of such an accident, PB is held (by an operator) in the 'pressed' position and the unlatching circuit is bypassed. However, in such a case one has to be very prompt in releasing PB instantaneously when the hand-set is lifted by a character on the stage, otherwise, the telephone bell will continue to ring even after the hand-set is lifted.

Fig. 2



The cost of the components (excluding the telephone instrument) works out to be approximately Rs. 170. The telephone instrument can be purchased in an old market.

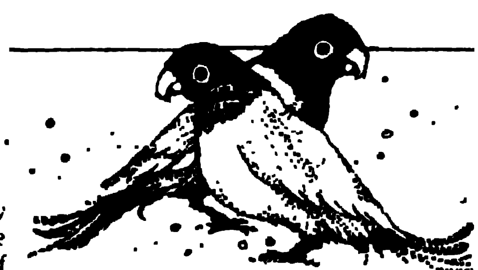
You will need:

Transformer: Pri. 230V AC; Sec. 1-60-80V AC; 500 mA, Sec. 2-9.0-9V, 500 mA
Semiconductors: IC_1, IC_2-74123; IC_3-7805; Q_1-CL 100; D_1-D_4-1N40003.
Capacitors. C_1 & C_3-47 F, 12V; C_2-10 F, 12V, C_4-100 F, 12V; C_5-100 F, 16V; C_6-1000 F, 16V; C_7-0.33 F, 12V; C_8-0.1 F, 12V.
Preset-pots: PR_1 & PR_3-10K, ¼ W; PR_2-1K, ¼ W; PR_4-22K, ¼ W.
Resistors R_1, R_3-15K, ¼ W; R_2 R_4-33K, ¼ W, R_5-2.2K, ¼ W
Relays. RL_1-DC 12V, 1 C/O. RL_2-DC 12V, 2 C/O.
Misc: PB-Push button, push to close; SW_1-Toggle switch, SPST 2A, 250V; F_1-Fuse, 1A, with Holder; Telephone instrument, with standard bell-coil (1.1K resistance), and a set of change-over contacts operated by hand-set.

Vinay B. Patankar
M. W. Pandit
Mr Patankar is an engineer from Hyderabad. Dr Pandit is a Scientist with the Centre for Cellular and Molecular Biology, Hyderabad.

BRAIN TEASER

Who keeps the lovebirds?



A BUILDING has six apartments. They are numbered from one to six with the odd numbers lying on the southern side of the central passage. Mr. Pathak lives in one of the apartments and manages the building. Pets are not allowed, however, five of the six families are allowed to keep birds. From the information given below can you deduce each family's apartment number and the type of bird owned by each family?

1) There are no birds across Herdias
2) One family keeps a canary.
3) The lovebirds live between the parrot and Bendres.
4) The parakeet lives across the bluejay and immediately next to the Watals.
5) The Anejas and the Watals live across each other.
6) Mr. Desai lives on the southern side of the building and does not keep a bird.
7) Mr. Herdia lives to the east of Mr. Watal.

G. V. Joshi

(Solution Next Month)

Solution to March teaser

The colour of the sticker

Let the total number of posters be 4N. As is evident from the problem, each son received N posters, and also that N leaves remainders 3, 4, 5 and 7 when divided by 11, 17, 27 and 32 respectively.

It is convenient to use the congruence notation, which in brief is
A≡B (mod C), that is, A leaves remainder B when divided by C
Hence,
N≡3 (mod 11),
N≡4 (mod 17),
N≡5 (mod 27) and
N≡7 (mod 32).

Upon using the popular high-school 'Chinese Remainder Theorem', we have

N≡17.27.32a+11.27.32b+11.17.32c+11.17.27d (mod 11 17.27.32).. (I)
where the natural numbers a, b, c and d are determined from the following congruences:
17.27.32a≡3 (mod 11), 11 27.32b≡4 (mod 17)
11.17 32c≡5 (mod 27), 11.17 27d≡7 (mod 32)
A simple check on these four congruences will reveal, a=1, b=4, c=13, and d=31. Substituting these values in (I), we get
N≡17 27.32.1+11 27 32 4+11 17.32.13+11 17.27.31
(mod 11 17 27 32)
≡14688+38016+77792+156519 (mod 161568)
≡125447 (mod 161568)

Since 4N is less than 10 lakhs, we have
N=125447
Hence, the total number of posters is 4N =4.125447=501788. □

Continued from page 28

1. Regeneration—B: It is the development of a tissue or a part of a living body to replace a similar structure that has been damaged or destroyed.

A conspicuous degree of regeneration is possible in some of the simpler animals, including sponges, coelenterates, and worms. When cut into pieces, the fragments undergo a reorganisation of their materials to form complete individuals of smaller sizes.

Salamanders, which closely resemble the lizards, are capable of replacing their tails after loosing it to their enemies. (See the science fiction story "The Salamander Factor" in SCIENCE TODAY, April 1984.)

2. Regression—C: Given two random variables, regression functions as the measure of the mean expectation of one relative to the other. Suppose a variate y is distributed in some form at each of several values of x, then a functional relation $y=f(x)$, is said to be a regression equation of y on x. The graphical profile of this relationship determined from the experimental data is called the line of regression. In psychology, regression refers to a mental state or a response to a difficult and unpleasant situation in a way no longer appropriate to the age and social status of the individual concerned.

3. Renal—B: An adjective referring to kidney; for example the renal corpuscle is a structural unit of the kidney. The renal artery is a branch of the abdominal or ventral artery supplying blood to the kidneys in vertebrates. The word is derived from the Latin *renes* meaning kidneys, whereas the prefix *re* in some of the words featured refers to again, *return* or back.

4. Reagin—B. An antibody which occurs in human atopic allergy such as hay fever and asthma and which readily sensitises the skin. When an antigen reacts with a specific antibody bound to mast cells, it leads to degranulation of the mast cells and release of vascoactive amines. These antibodies are termed reagins.

5. Realgar—C: A mineral of Arsenic mainly in the form of a sulphide. A red to orange mineral crystallising in the monoclinic system, having a resinous lustre and found in short, vertical, striated crystals; specific gravity is 3.48, and hardness is 1.5-2 on Mohs scale. Also known as red arsenic, red orpiment, and sandarc.

6. Relaxin—A: A hormone found in the serum of humans and certain other animals during pregnancy, probably acting with progesterone and oestrogen, it causes relaxation of pelvic ligaments.

7. Reamer—C. A tool used to enlarge, shape, smooth or otherwise finish a hole.

Two-lipped twist and straight fluted drills are satisfactory agents for originating holes, but if a cored hole is to be finished or if drilled hole is to be enlarged, two lips do not provide sufficient support for the body of the drill and an irregular, non-cylindrical hole will result. For this reamers have to be used.

8. Recessive—B. A gene that is not expressed when there is a dominant allele present.

In homozygous conditions, that is when both the alleles present are similar and recessive, then it is expressed. A very famous example of a recessive gene is the one responsible for causing haemophilia. It is a sex linked character and is located on the x-chromosomes. In the female both the sex chromosomes are x, the other allele being dominant, this remains unexpressed. So the woman is only a carrier. In males it is expressed because there is no dominant partner to suppress it.

9. Rectilinear—C: Consisting of or bounded by lines.

10. Refractory—A. Refers to heat-resistant properties of materials which resist change of shape, weight or physical properties at high temperatures. These refractory materials chiefly used are fireclay, silica, kaolin, diaspore, alumina and silica carbide.

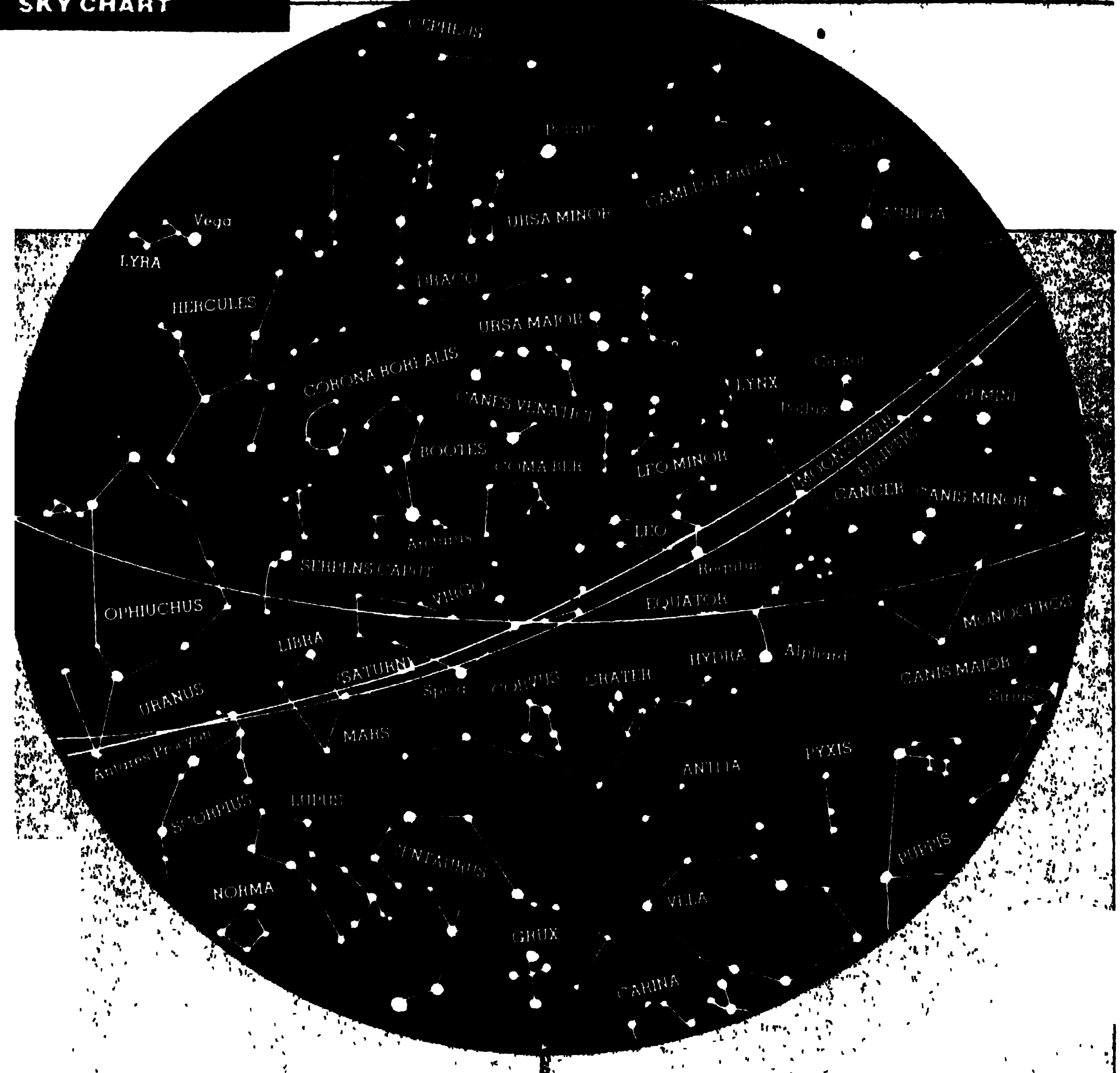
The term also generally describes resistance to a particular treatment.

The Winner

WE asked you to show us the full scope of your knowledge of 'scopes' for our quiz of March 1984. And we got quite a scenario of scopes—though admittedly not as large as the response to our request on meters! We hope Joy M. P. of Elanoor, Kerala will be overjoyed at being declared winner with his meticulous compilation. He deserves special congratulations for he had also sent a sizable essay on meters.

Win a prize!

FOR this month's quiz, first find the odd man out from among the ten terms given by us. Then we would like you to give us detailed explanations on the following six terms: Resonance, Recombinant, Repot, Rebozo, Rectocele and Rectocornia. Send us your entries by 5 July 1984. Happy Researching!



SKY IN MAY 1984:

Saturn and Mars are at opposition with the Sun

Nagpur 21.00H (IST) As on 15 May 1984
Magnitude Limit = 21 9' N Longitude = 79
Longitude = 79°6' E Sidereal time 12h 20m, 34.4 Sec.

When a planet (necessarily outer) and the Sun are placed in the sky diametrically opposite to each other, the planet is said to be at "opposition" with the Sun. It means that when the Sun sets in the west, the planet rises in the east and remains visible for the whole night. This month Saturn will come to opposition on 3rd and Mars on 11th. Both of them are now to be seen in Libra. Mars, being the brighter between the two, is placed slightly east of Saturn (see the chart). Mars will definitely appear brighter than Sirius, the brightest star in the sky. It will become brightest on 15th and outshine Sirius by about forty per cent (magnitude -1.9). This is because of fair closeness of Mars to the Earth. On 19 May, Mars and the Earth will be so placed that a signal of light will take as little as four minutes and twenty-five seconds to travel between them.

Now Jupiter is also very bright as it is approaching the opposition in next month. Jupiter (magnitude -2.5) is now about ten times brighter than Saturn (magnitude $+0.1$) and nearly twice as much as Mars. Jupiter will rise about three hours past the local sunset and be present in the constellation Sagittarius.

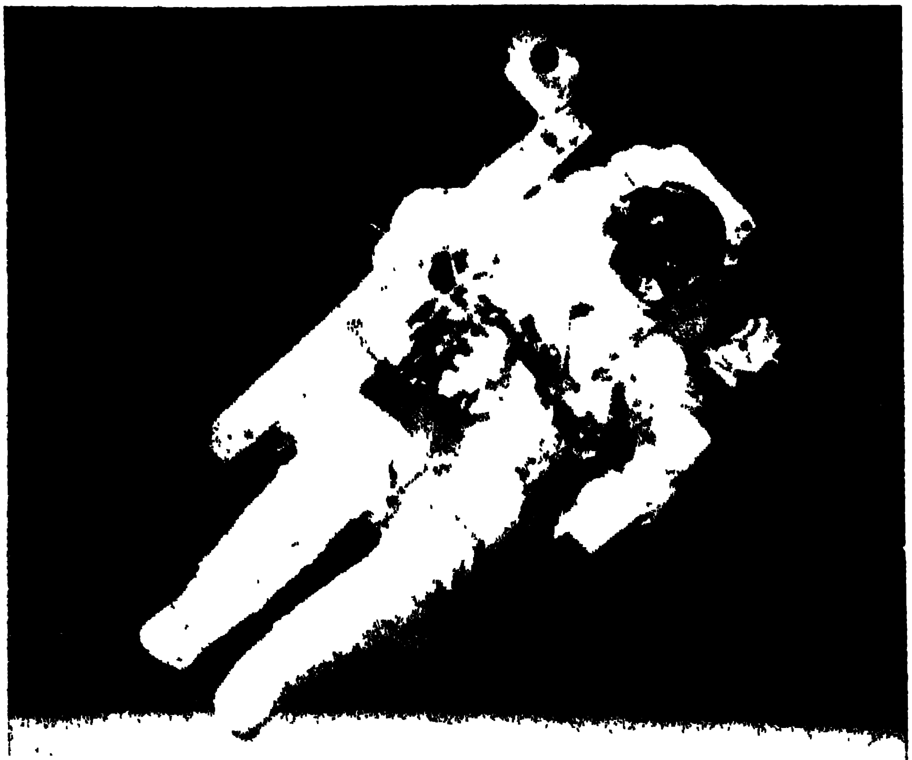
This year particularly is very bad for observing Uranus. Though Uranus is now very bright compared to its own standard (magnitude $+5.5$), it is unfortunately located in an area of the sky where the Milky Way is quite thick. Its position is however been marked by a cross in the chart (see slightly above the star Antares in Scorpius).

Venus is already lost in the morning dusk. In its orbit it is now slowly approaching the far side of the Sun. It will however reappear in the evening dusk by the end of July. Mercury is well-placed in the morning sky, becoming brighter every-day. It will rise about an hour and a half before the local sunrise around 20th and at a location about 15 degrees south of Hamal in Aries.

N. C. Rana

TELL US

... how does one WALK IN SPACE



"That may have been one small step for Neil, but it's a heck of a big leap for me"—Bruce McCandless.

THE US astronaut Bruce McCandless became the first human satellite on earth when he leapt out of space shuttle Challenger on February 7, 1984. Earlier too astronauts had walked in space, but only with a life line attached to the space craft. Astonishingly, McCandless orbited the earth floating in free space *without* any life line attaching him to the space craft.

This miraculous act untethered space walk—was made possible through an ingenious high technology device called "jet propulsion backpack" Using this backpack, the astronauts could go as far as 45 metres away from the parent craft Challenger.

The jet propulsion backpack, a 10 million US dollar device makes it possible to propel oneself in space Also called "Manned Manoeuvring Unit (MMU)", the package is a mini space-craft, so to say. The principle on which it works is quite simple when a jet of gas is ejected from an object it tends to move in the opposite direction —Newton's third law. The design of the unit is quite complex: but one can learn to operate it in a matter of a day's training.

The backpack is powered by 24 nitrogen thrusters each with a thrust of less than a kg. These are situated all around the unit making it possible to move in any desired direction. The mechanisms are so precise that the unit can be manoeuvred to within inches from objects in space—such as a moving satellite

The MMU weighs about 150 kg and with an astronaut and his life support system it will have a *mass* of about 300 kg. Due to weightlessness in space even a small thrust is enough to make sufficient movement However, we should remember that when an astronaut walks out of the space craft he will be flying beside it at about 28,000 km per hour, the same speed as the shuttle at an altitude of nearly 250 km

The MMU is flown using two hand controllers mounted on structural arms. The right hand controller is used to command altitude, changes in yaw, pitch and roll around a fixed point. the left hand controller is used for commanding thruster firings to move from point to point. It is pushed in to move forward and pulled out to go backwards.

The nitrogen for propulsion is filled in two 25 × 75 cms tanks each with 6 kg of nitrogen at nearly 200 times the atmospheric pressure. For redundancy, the system is divided into 12 thrusters operating on gas from one tank and the other 12 from the second. Even if one system fails, the MMU can be safely manipulated using the other. For moving from one point to another, four of the thrusters are normally fired while two thrusters are fired for altitude changes when the astronaut desires to pitch forward or backward.

The astronaut does not have to command a particular thruster or thrusters. From the hand controlled input—light pressing of buttons—the electronics will choose the correct thrusters for the desired movement. The jets will fire as long as the hand controllers are pushed. One can fire just for a fraction of a second for precise manoeuvring.

The unit gets its power from two silver-zinc batteries with separate primary and back up strings for the electronics. The batteries can be replaced with ease by the astronaut and the nitrogen gas can be recharged within about ten minutes by attaching a hose to the MMU from the support station. With a full charge of the gas cylinders an astronaut could operate in free space for about 2 to 4 hours depending on the complexities of manoeuvring.

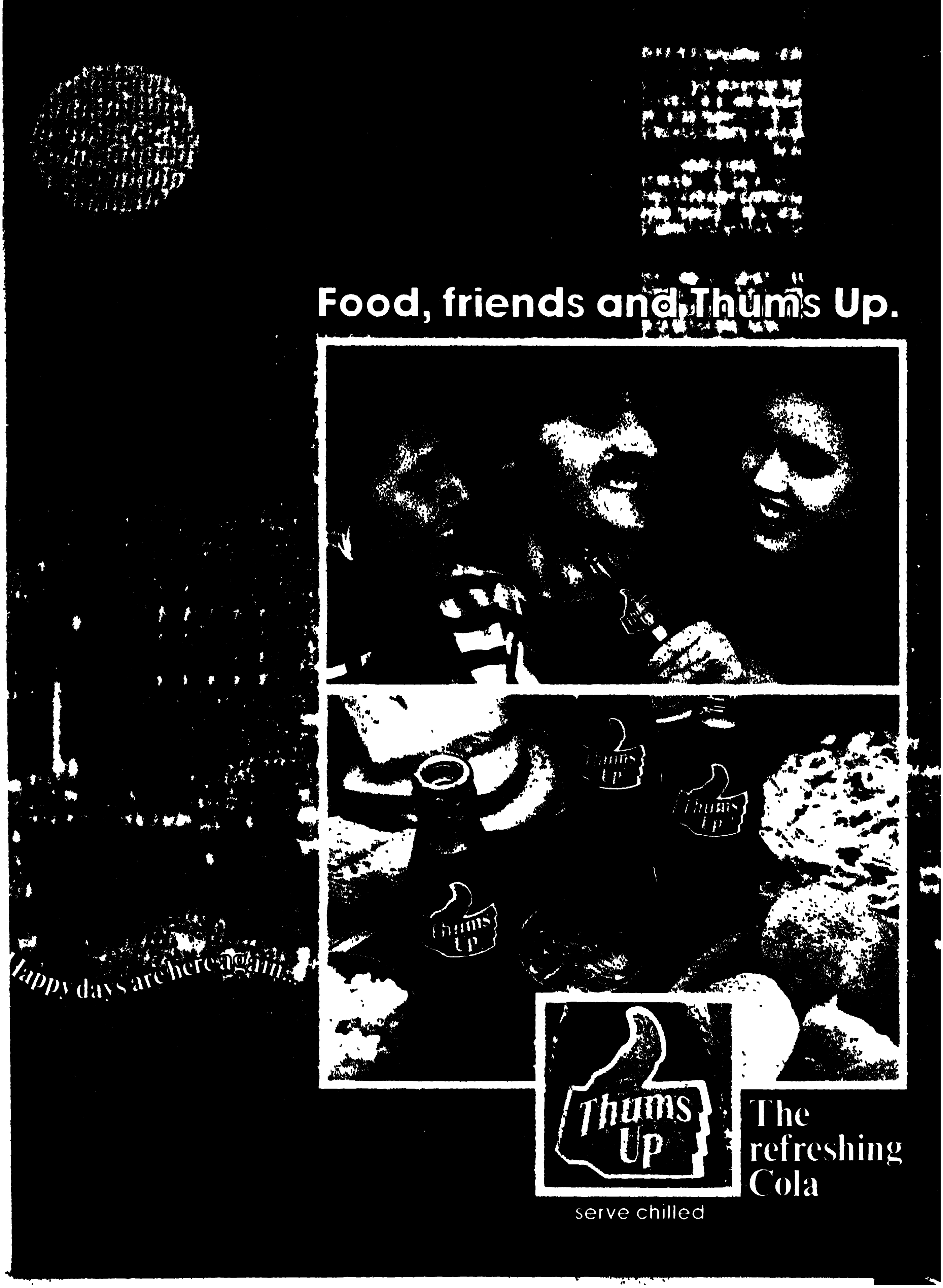
There are three gyros in the manoeuvring unit for maintaining the MMU's altitude in free space which, working in connection with the propulsion system reduces nitrogen propellant consumption. McCandless took about 12 minutes to have a 'long' flight of 50 metres from the Challenger. The ease with which this is achieved can be seen from the fact that when McCandless and Stewart were performing a space walk together, they were quite relaxed, joked a lot and did a few somersault for the fun of it. At one stage McCandless retrieved a metal foot restraint that got drifted away while practising "satellite repair techniques". Quipped McCandless, "we not only deliver, but we also pick up".

In the not distant future, a number of astronauts with MMUs will be floating in space building space colonies for prolonged periods of stay.

V. S. Venkatavaradan

Dr. Venkatavaradan is Director, Nehru Planetarium & Discovery of India Project, Nehru Centre, Bombay.

Regd. No. TN MS(C) 522



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June 1984 Rs. 4

SCIENCE TODAY

AH! THE RAINS ARE HERE!

Potholes, housefalls and gastro to follow...

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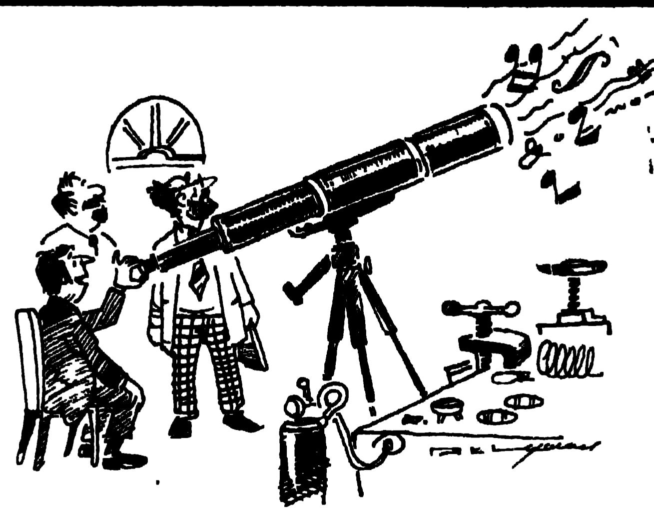
June 1984

SCIENCE TODAY

Vol. 18 No. 6

Features

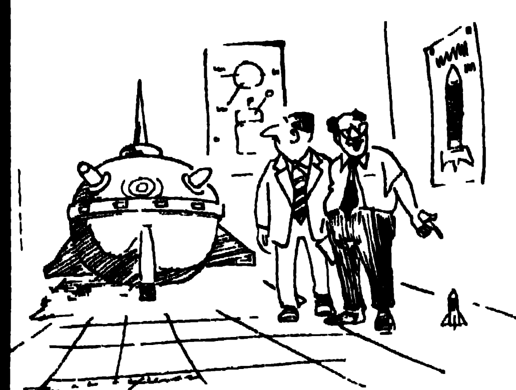
Why have you called the police manager? When I complained this hotel room is bugged I meant the real bugs!



Of course it is a radio telescope just as you ordered— you just turn this here and there you are!

R. K. Laxman

At last the research and development wing has submitted its report Sir it says there is scope to develop a soft drink called Vh because that name is not used by any one yet!



Actually the bomb inside is just that size We give it the deadly outside look for selling it to the developing countries

SCIENCE TODAY

Vol 18 No 6 June 1984

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Regd No TN/MS(C) 522 Regd No MH By South 317

THE much-awaited report of the prestigious British science weekly Nature on "Science in India" has at last appeared. The [illegible] information and material for this, special correspondent [illegible] camped in India for a fair length of time and Dr. [illegible] the editor himself paid not-too-brief a visit. Their report has a [illegible] title. "Among developing nations", they say, "India has by far the [illegible] chance of succeeding. The doubt is not whether but when." After stating the now oft-repeated, almost cliched obstacles of [illegible] illiteracy, poverty, cultural as well as geographical diversity and [illegible] political interests, the reporting team passes judgement that [illegible] circumstances, it is remarkable that so much has been achieved. The report then goes on to provide bird's-eye-view profiles of "some [illegible] splendid (scientific) establishments".

On reading this lengthy 20-page report we were reminded of Mark Antony's immortal lines in Shakespeare's Julius Caesar: "I have come not to praise Caesar, but to bury him", proclaims Mark Antony, "For Brutus is a honourable man". "We have not come to bury science in India. We have come to praise it", the Nature report could very well have had that title.

The report is said to be a compliment but it is a left-handed one at best. "Prejudices are not meant to show", it says. Yet they do, like the chiselled features of the "Veiled Rebecca" at the Salarjung Museum in Hyderabad where the Nature team spent a good part of their time. How else can one explain the question, "Can it be in India's best interests that so much bright enthusiasm should just now be invested in the replication in Indian laboratories of machines... that can be bought across the counters of retail shops elsewhere in the world?" That too after having supposedly understood that the philosophy governing India's scientific programme is one of self-reliance?

One might excuse this "view from the west" as a genuine personal opinion to which everyone is entitled. But even the coverage of the scientific activity is lopsided. Having realised that almost a quarter of the total government science budget is spent on the Departments of Atomic Energy and Agriculture, the latter's work is dismissed in just as much space as that accorded to a single department of an affiliated college of the University of Bombay. Atomic energy is made conspicuous by its absence. So is the Indian Institute of Science or the All India Institute of Medical Sciences. TIFR gains the dubious distinction of a passing mention.

To us, the report has thus come as a sore disappointment. This is not to take an "I'm alright Jack" attitude and say that everything is well with science in India. But a detached view that it should have been is expected to display a sense of proportion. Nonetheless, slighted as it is, it has served an eminent purpose. It has provided the spark that should ignite a flaring debate among the practitioners of science in India. Such a debate can only augur well for its health. SCIENCE TODAY, being committed to the welfare and well-being of Indian science, is willing to provide the forum for this debate.

EDITOR

SCIENTIFIC ANCIENTS

Congratulations for the article 'The waterworks of the great pyramid' (August 1983) It has removed the shroud of mystery, romanticism, and supernatural from the face of the pyramid

The ancients in fact did have their own scientists. The *Jantar Mantar* observatory, the architectural engineering of Taj Mahal, the chemistry of the iron pillar in Delhi which has not rusted to date, Unani and Ayurvedic systems of medicine, the biochemistry of the Egyptian mummies which have not rotted even till today, are some examples of the advanced level of science in ancient times. *Surya Siddhanta* and *Aryabhatt Brihat Samhita* of Varahmihira are some great Indian scientific works.

SANJEEV PRAKASH

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Jamshedpur 831003

"Mention of TSS must on tampons"

Thanks for the timely article on TSS (The Tampon Syndrome, Women & Science, February, 1984). Drug companies (national as well as multinational) are very irresponsible as far as social responsibility is concerned. Their main aim is profit and the health aspect takes a secondary position. As far as the 'tampon affair' is concerned the manufacturing companies MUST make a mention of TSS, as is done abroad.

Can we expect the correct response from concerned authorities?

D. L. KARAD

Pimt Nasik Maharashtra

Science, and not 'big' or 'small' is needed

Congratulations for the rational views on the debate between 'big' science and 'small' science (CLOSE ENCOUNTERS, February 1984) Such a controversy is not at all relevant in a developing economy. The ultimate aim of every scientist is to unfold nature's mysteries to create means of production and distribution. Such means are supposed to be economical and labour-saving. So, whether major scientific research projects are undertaken at macro-level or small ones are undertaken, the purpose, ultimately, is to give a push to the national economy

Just to give one example, space research should prove fruitful for the entire mankind. And one would wholeheartedly endorse your views, "time has come, therefore, to stop these divisive arguments and put up a united front to oppose the anti-science league which alone benefits from futile debates".

VINEETA SINGH

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NASIK-422 207 (Maharashtra)

Women on the march

A UNESCO International workshop on 'The Role of Women in the assimilation and spread of technological innovation' will be held at the National Institute for Training in Industrial Engineering, Bombay, during 29th October to 2nd November, 1984. Contributory research presentations and delegates are invited. The workshop is open to men and women. Last date for abstracts of papers is 31st July, 1984.

Abstracts of papers and enquiries may be directed to the undersigned.

MADHURI SHETH

Convener
National Institute for Training in Industrial Engineering Vihar Lake
Bombay 400 087

Maths Olympiad

Please refer to the article 'Because maths is fun' (Youth Forum, April 1984), giving interesting details regarding the 'Maths Olympiad—84' conducted by the Mathematics Association of the IIT, Bombay. I was particularly interested in it as I had the pleasure of being one of those thousand plus participants

Here, I would like to draw your attention to a contradiction that has occurred in the case of the very first question mentioned in the article.

The answer which has been calculated in the article seems to be absolutely right. But if we take a look at the problem from another angle, a more common sense approach seems to come up with different answers altogether. The problem stated that the average of the first five numbers is 80 and that of the last six numbers is also 80. It is plain enough that there being only 11 numbers in the group, the average of the entire group is also 80. Similarly if we consider the other two statements, we get a figure of 72.7272... as the combined average.

The controversy arises not because the methods adopted are wrong, but simply because there is a lacuna in the problem itself. If we assume the first three figures of the given data to be right, then the fourth figure has to be 92

$$\left(\frac{80\times6+80\times5}{11}=\frac{70\times6+92\times5}{11}=80\right)$$

We can show similar results with the remaining figures also. It shows that none of the figures is consistent with the three remaining ones.

I understand that this sort of mistake is due to inadvertence only, but it can't be an excuse for a reputed organization from the IIT I would also like to assert that I fail to understand the need to go in a roundabout way to reach the solution. It is this needless sticking to systematic ways which makes people run away from the glorious world that mathematics is.

CHETAN P. DIGHE

72/2441 Nehru Nagar,
Kurla (E), Bombay 400024

We regret the error that crept in the problem inadvertently. We became aware of it when the Olympiad was in progress. No marks were allotted to that particular question when answer papers were evaluated

SUDHIR R. GHORPADE

General Secretary,
Mathematics Association
Indian Institute of Technology,
Powai, Bombay 400 076

We have received a large number of letters on the subject. Our oversight in selecting an erroneous problem is regretted.

Editor

[illegible]

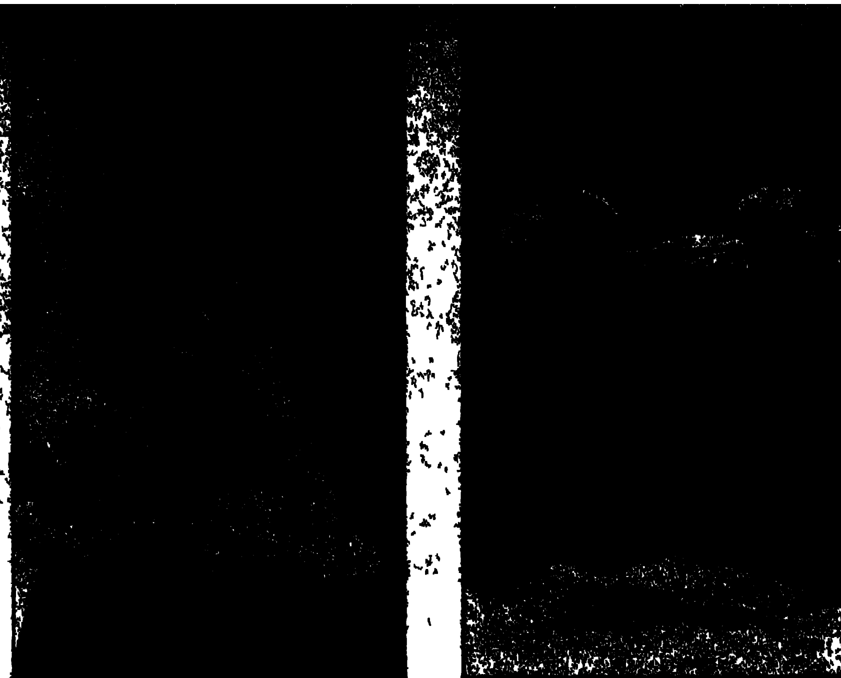
The calls she did not make

HAVE you heard of a telephone bill running into 2,578 pages and amounting to US$10,950,488? Jane Landenberger, a resident of Bedford, New York, received it as her February 1984 bill which weighed 9 kg and listed more than 17,000 long-distance calls to persons living as far as Asia and Africa. Poor Jane also received a call from a supervisor at New York Telephone confirming that all those were bonafide calls. As it turned out, bonafide indeed they were but not of Jane's. Obviously she was a victim of telephone frauds. Her corrected bill amounted to only $47.08.

Phone frauds are becoming common in the US. In 1982, illegal telephone credit-card use accounted for nearly $69.5 million and in 1983 it was $71 million.

How Jane was tricked was difficult to trace. There were instances of stolen telephone credit cards being traded or eavesdropping at public phone booths where callers give card numbers to operators. In Jane's case, according to a spokesman for New York Telephone, her number was posted on an electronic bulletin board—message centres for personal computer users—from where the phoney caller could have picked it up.

The board consists of a modem, a device which allows a computer to send and receive messages over the telephone lines. The user dials the bulletin board and leaves or picks up messages. Occasionally, some boards carry private access codes to long-distance services which distribute the personal identification number (PIN) used on telephone credit cards. Some micro-computer users consume a lot of long-distance telephone time and a few of them at least may prefer to have someone else pay for it. Understandably, they would like to cover up their telephone trail and the only way is to look for valid access codes or phone credit card numbers



The Bond-style cigarette lighter (left) doubles as a camera (right)

Gas-fired camera

AT last you can walk into a shop and pick up a James Bond-style gadget—a slim cigarette lighter that also takes 36 photographs—ideal for secret agents or snooping journalists.

The ten-cm butane-filled lighter conceals a mini-camera with special noise-free gears that won't alert your subject.

The camera takes standard Minox film, in ASA speeds of 125 to 400. The tiny negatives enlarge into 3 x 5 prints in colour or black and white. It can slip into your pocket, unnoticed, ready for that swift exposure

(Asia Features)

—Francis Rafferty

"High" on leadership

A LEADER cannot lead effectively unless he gets continual shows of respect and submission from his subordinates. A female leader, however, does not need these reassuring kowtows in order to be effective. That is what [illegible] are likely to conclude from a study by an American Professor of Psychiatry, Michael McGuire, who has been studying the brain chemistry of monkeys and men at the University of California in Los Angeles, USA.

McGuire found that the dominant (alpha) male in groups of vervet monkeys had a blood serotonin level twice as high as that of the other males. When the "boss" male was isolated, however, his blood serotonin levels fell to those of the subordinates within a week to 10 days. In the same period a new group leader would emerge and his blood serotonin would rise to the "leadership high" Furthermore, it emerged that this high count of serotonin could only be sustained by continual feedback of gestures of submission from the subordinates. To test this finding, a dominant male was isolated and placed behind a one-way mirror so that the monkey could send dominance signals—threatening expressions and aggressive gestures—to the rest of his group but could not see the response from them to his "bossing". As a result the leader's serotonin levels fell to those of his subordinates almost as quickly as when he was completely isolated. Female monkeys in the earlier studies show no variations in serotonin levels although they have their own hierarchies separate from those of the males.

McGuire then studied officers from student fraternity organisations in the University of California and found that they had considerably higher serotonin levels than those of other student members.

He is now planning to make similar measurements on men undergoing major changes in life; retirement, job demotion, extended personal crisis and the assumption of leadership in small groups at work He also hopes to study serotonin levels in female humans.

McGuire himself is careful about drawing too many conclusions from his work at this early stage. Women may see it as evidence that the male ego is unduly sensitive to signs of respect or the lack of it.

Choose the sex of your baby

NOT many married couples know about it, but a technique exists that

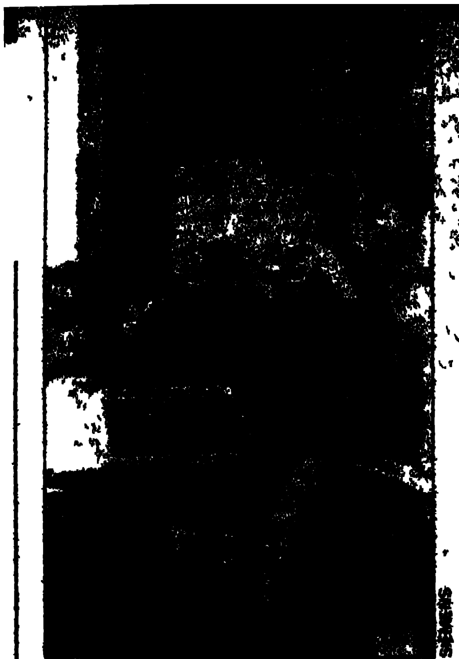
may afford them a 75 per cent chance of choosing the sex of their baby, that is, if a boy is what they want

Each human cell has 23 pairs of chromosomes, including the 'sex chromosomes' XX in the female and XY in the male. A fertilised egg may develop into a male or female depending on whether the chromosomal constitution is either XY or XX. This is true for all cells except the female egg (ovum) and spermatozoon (sperm) which has haploid (one set) number of chromosomes. The ovum before fertilisation thus contains an X chromosome while the male has sperm having both X and Y chromosomes. If a Y-bearing sperm unites with the ovum which has X chromosome, a male offspring is conceived while if the X-bearing sperm unites with the egg having X chromosome, a female child is conceived. Since the Y chromosome is present only in man, a woman who wants a boy stands a better chance if only a Y-sperm fertilises the ovum. This can be achieved by separating X and Y spermatozoa and inseminating the woman with Y-sperms.

The technique employed to choose the sex of the offspring is known as the Ericsson Method or the Albumen Separation Method. It was developed and patented by Ronald Ericsson, a reproductive physiologist from the US. The Ericsson method has been used in 17 sperm centres around the world in the last five years, with a success rate of nearly 80 per cent.

The procedure calls for the wife to be artificially inseminated with her husband's male (Y-bearing) separated sperm. In the Ericsson Method, to increase the chances of conceiving boys, the sperms are "washed" by spinning them down in a centrifuge that separates them from seminal fluid. They are then placed on top of glass columns that contain a layer of albumen, a constituent protein from human blood. The sperms then swim and battle their way through the albumen to the bottom because of more strength and motility These are 70 to 80 per cent male sperms with the Y chromosomes. These selected survivors are then extracted and subsequently inseminated into the ovulating woman. If she conceives and carries to term, the odds are seven in ten that she will have a boy

—Wijaya Altekar



Communication with a difference

PEOPLE with impaired speech or hearing will soon have a new mode of communication. They would be able to telephone to each other over long distances through sign language using videophone. Besides, tiny tots will have a merry time with their grandparents *(see above left)*.

The West German government has given the green signal to the trial running of BIGFON(wideband integrated services local network with optical waveguides) with 350 selected subscribers in Berlin and six other cities. These will be provided with telecommunication facilities such as telephone service, telex, interactive video-tex and data services via two hair-fine glass fibres *(see above right)* instead of numerous copper wires. Twenty per cent of these subscribers will enjoy the facility of videophone.

When the Earth held its breath

FOR the first time in this century, the geological time scale spanning the ages has been extended by a new "formation". The geological time scale covers the whole period of the Earth's history and is segmented into stages Hence, we have the early age consisting of six periods—Permian, Carboniferous, Devonian, Silurian, and Cambrian characterised by echinoderms like the star fish and sea-cucumbers, followed by the middle age with the Cretaceous, Jurassic and Triassic periods, characterised by ferns, conifers and modern types of fishes, and lastly the modern age with the Quaternary and Tertiary formations The latter included the early mammals like the insectivores, and early monkeys.

The new "formation"—Ediacarium—which precedes the above mentioned stages, has been considered now as a stage independent of the others. Although multicellular organisms did exist in this stage, the Ediacarium period is now beginning to be looked upon as the time when the transition of unicellular organisms to fully developed multicellular organisms took place.

This new formation, Ediacarium, has been so named as the first remains of the naked multicellular organisms were discovered in the Ediacara Hills in Australia. Fossils have been later found at several places, including south west Africa, the Antarctic, Scandinavia, Great Britain and Siberia. Twenty-nine different species have already been identified here Two-thirds are cnidaria, like medusae or sea feathers belonging to corals then there are the annelids and several arthropods in a "soft body version", a few controversial soft echinoderms, and other forms of life which have not yet been clearly classified

Professor Klaus Sdzuy of the Würzburg University, W Germany while studying similar types of fossils in the Atlas Mountains in Morocco remarked: "A strange, almost incredible picture,, revealing a period of inactivity in the hydrosphere and atmosphere, utterly foreign to us in this day and age," prevailed at the time. This clearly implies that the environment during this

[illegible]

period would be rather unusual. Rocks that were formed were deposited in completely uniform layers at sea-level, undisturbed by currents. Apparently, there were no wave movements on the sea at the time, as there was no evidence of ripple marks on the fossilised sea-bed. So for 100 million years there appeared to be no wind.

This strange calm saw multicellular organisms devoid of any hard parts, and as there were not enough microbes at the time, biological decomposition of dead organisms possibly took place very slowly. This peculiar state ended about 550 million years ago, and with it the environmental energy started increasing, movements in the atmosphere and sea began, and creatures slowly started to develop hard parts.

Cause of AIDS found

VICTIMS of acquired immune deficiency syndrome (AIDS) can now set their hopes on a virus discovery in France. According to James O. Mason, head of the Federal Centres for Disease Control, USA, the French virus is the cause of the disease He, however, stressed the need for additional research to confirm the findings

NATURE

Section of vaginal mucosa

The French virus is called LAV for lymphadenopathy-associated virus It is a member of the retro-virus family, which over the past year has been the leading candidate as the cause of AIDS

One of the reasons for believing LAV as the cause of AIDS is that tests first done in France have shown that the virus attacks the same white blood cells called OKT4 or helper T-cells that are destroyed by the disease.

Meanwhile, the dreaded disease which has claimed 1,758 lives in the US since 1981 has crossed political boundaries. Confirmed cases of AIDS have now been reported from Czechoslovakia. The victims are said to be a Slovak and an African. There are also unconfirmed reports of the disease from East Germany belying the earlier consideration that AIDS is a disease of capitalism.

In Poland, the possible threat of AIDS is taken rather seriously especially because the recent political upheavals have led to a considerable decline in hospital services. Unconfirmed reports of AIDS from East Germany seem to have activated the Polish Institute of Hygiene to issue special guidelines for doctors for quick and correct diagnosis of AIDS. Blood donor stations have been cautioned against receiving blood from AIDS victims.

The question arises as to why homosexual men exposed to semen by anal intercourse are more prone to be im-

NATURE

Section of rectal mucosa

munosuppressed and subsequently an easy prey to other diseases than women The answer to this lies in the tissue structure of vagina and the rectum. The vagina is lined by thick stratified layers of squamous epithelium below which lie the vascular lamina propria, richly supplied with blood and lymphatic vessels In contrast, the rectum is lined by a single layer of simple columnar epithelium, which allows the breach of a barrier between this columnar epithelium and the underlying blood vessels and lymphatics of the rectal lamina propria. This simple anatomy of the vagina and the rectum makes the former more resistant to ulceration and to infiltration of semen into the important vascular layer lying beneath the epidermal layers.

Also, the nature of sexual intercourse plays a role in acquiring AIDS. Women rarely engage in anal intercourse as frequently as promiscuous homosexuals. And still, women do get AIDS. In this context, it is probable that these women have had anal intercourse with bisexual men The semen of homosexuals is known to have greater immunosuppressive potential than the semen of heterosexual men, possibly due to autoimmune-induced changes in cellular and or soluble components of semen. If this is true, women who have anal intercourse with bisexual men may be more prone to AIDS than those who have anal sex with heterosexual men. And a recent study to be published in the *Journal of Medical Association* reports just that—women who routinely engaged in anal intercourse exhibited immune abnormalities

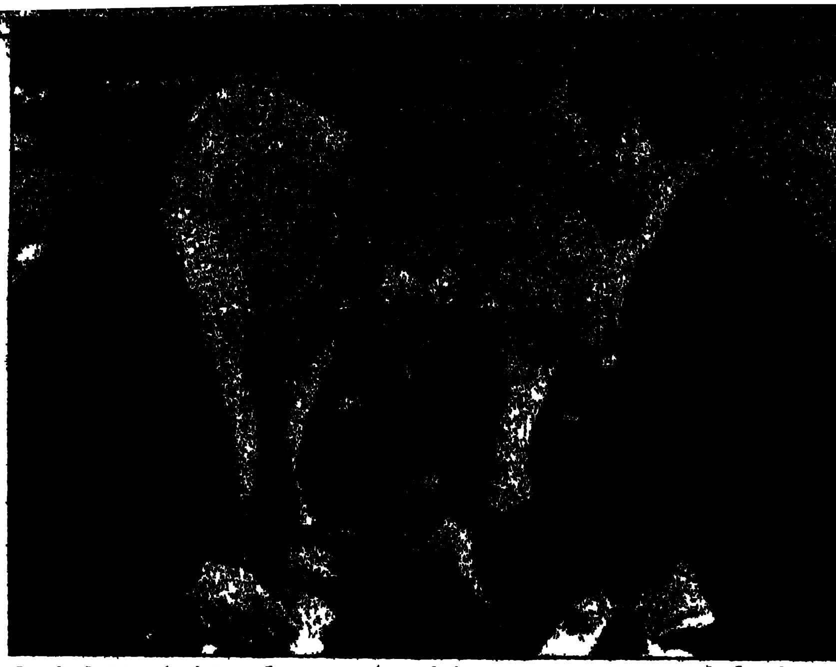
Cancer makes dangerous inroads

CONTRARY to common belief that cancer prevails more in the West, the disease has more victims in the developing world according to a recent global cancer study by the World Health Organisation (WHO)

Of the 4.3 million people that die of cancer every year, more than 50 per cent are from developing countries A breakdown shows that 1 86 million deaths are recorded in Asia alone, followed by 1 4 million in Europe, 447.000 in North America, 291,000 in Latin America, 268,000 in Africa and 32,000 in Oceania

According to the study, in India and China, the world s two most populous nations, from a quarter to a third of all males "are addicted to tobacco smoking, the major cause of lung cancer" by the time they are 18 to 20 years old.

One of the contributing factors to this addiction is the "highly sophisticated and ruthless" smoking promotion campaigns conducted in the Third World In Malaysia, the study says, tobacco com-



Sweden's King Carl Gustaf presents the Nobel Prize to Pyotr Kapitza(left) for pioneer work in low-temperature physics

Pyotr Kapitza — towering figure of Soviet science

PROFESSOR Pyotr Kapitza, the renowned Soviet physicist, passed away on April 8, at the age of 89. He was a recipient of the Nobel Prize in physics (1978) for his basic inventions and discoveries in low-temperature physics.

A series of experiments conducted by Kapitza led to the discovery in 1937 of superfluidity—a totally new property of matter. This outstanding discovery was made possible by a new and original apparatus Kapitza had earlier developed for liquefaction of helium

His experiments on liquid helium established beyond doubt that this fluid behaved peculiarly at very low temperatures—it had no viscosity at all. It could pass through narrow slits effortlessly and almost instantaneously A normal liquid like water, on the other hand, took several days to pass through the same slits.

Kapitza, son of a Czarist general, was born in 1894. He started his scientific career at the Petrograd Polytechnic at St. Petersburg. He left for Cambridge in the UK to work with Ernest Rutherford in 1912. It was said of Kapitza that he had the same zeal to enjoy science with an unbridled energy and power of imagination as his master Rutherford In addition, Kapitza was said to possess a streak of Russian eccentricity, which probably meant that he was far less conventional than his British counterparts.

In the congenial atmosphere of Cambridge, as Rutherford's favourite, Kapitza plunged into his famous experiments of generating very strong magnetic fields Rutherford was largely instrumental in securing for his brilliant and daring pupil "baby giants' of high voltage Kapitza was successful in obtaining fields upto 320 kilogauss in a volume of 2 cubic centimetres He went on to study the resistivity of metals in very strong magnetic fields and discovered the linear law that bears his name.

Kapitza's attitude to science is apparent from the following episode. A new laboratory was specially built for him in Cambridge which was named after Mond, the multimillionaire chemist At the opening ceremony of the laboratory people were taken aback to see a huge crocodile carved on the facade When enquired about it Kapitza retorted "Well, mine is the crocodile of science The crocodile cannot turn its head Like science it must always go forward with all-devouring jaws "

Ironically, Kapitza was not to work for long in his newly built laboratory. When he made a trip to Moscow in 1934, he was persuaded by the government to stay back on the plea that his services were indispensable to fight the danger of Hitler Rutherford then took an unprecedented step and arranged to dismantle the bulky apparatus that Kapitza had set up at Cambridge so painstakingly and sent it over to Kapitza, the Soviet Union not only came forward to pay for the apparatus, but also established a new institute appointing Kapitza as its director.

After the discovery of superfluidity in 1937. Kapitza engaged himself in applied research—production of oxygen using low pressure expansion turbines and its uses.

Later, Kapitza turned his attention to a totally new range of problems He invented high power microwave generators and discovered a new kind of continuous high pressure plasma discharge (1950-55)

Kapitza was at the helm of Soviet science probably until he raised his voice against the use of atom bomb in 1946. He was a member of the USSR Academy of Sciences, a fellow of the Philosophical Society of Cambridge and the Royal Society of London, a member of the American Physical Society... a list far from complete.

Kapitza was one of the finest experimenters of our times He often expressed the view that for any good work one has to depend on one's own hands. His contribution to the progress of science is immense, his complete works published in three volumes bear ample testimony to this fact

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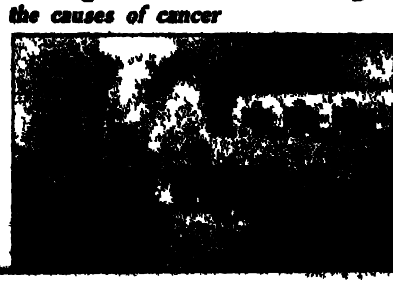
panies recently spent US $ 5 million on 12 months advertising—about US $ 360,000 for every man, woman and child in the country

The high tar and nicotine contents in the cigarettes sold in the Third World contribute to the increasing lung cancer, reports the study For example, the tar yield in cigarettes sold in India can be as much as 66 times higher than in the low-tar cigarettes sold in industrialised countries

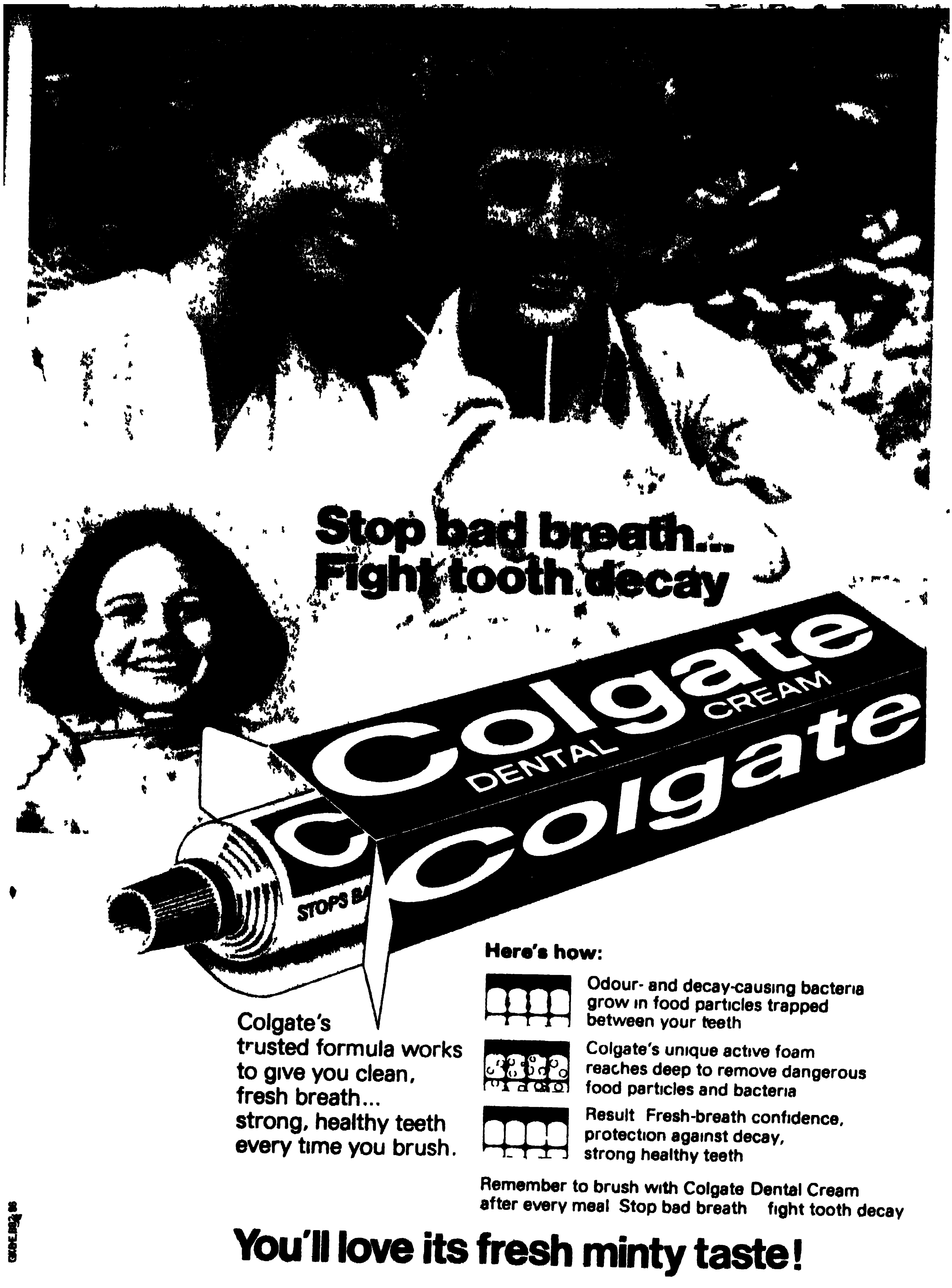
India is one of the Southeast Asian countries where mouth cancer incidence is high This is avoidable if

Smoking machine used to investigate the causes of cancer

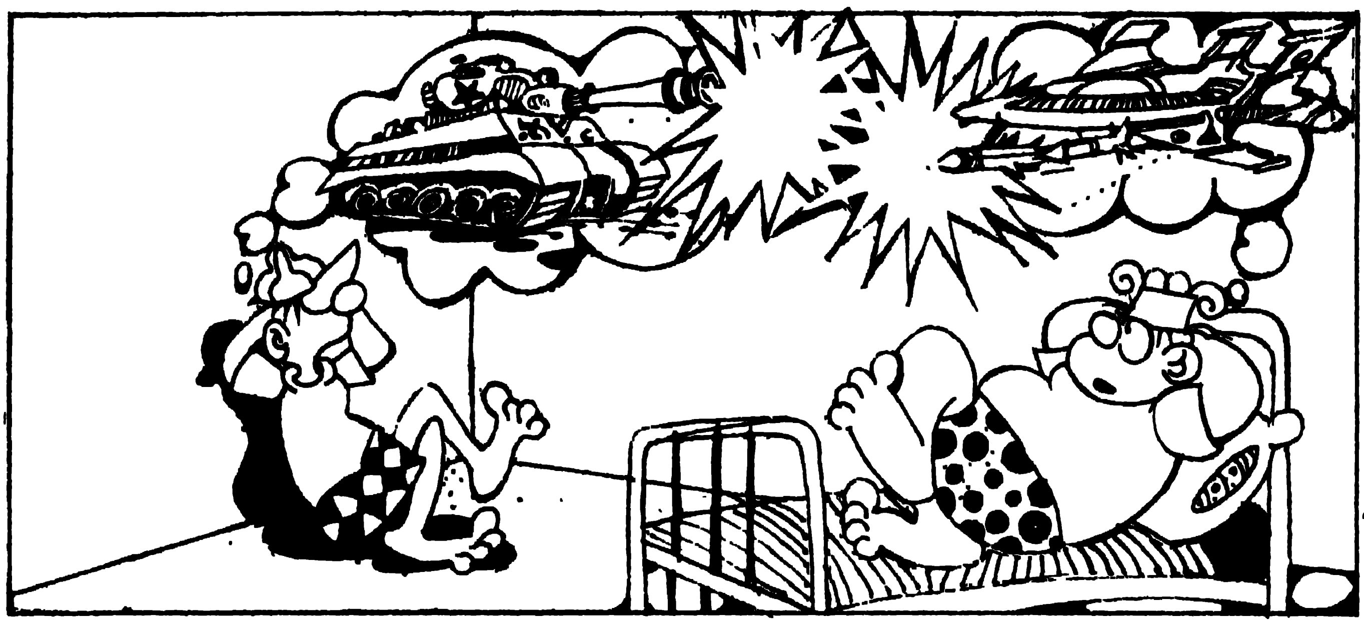


chewing of betel nut and tobacco quid is discouraged WHO estimates 100,000 new cases occur yearly, with 90 per cent caused by local forms of tobacco-chewing and smoking

One positive aspect of WHO's study is that liver cancer appears to be preventable by vaccination against Hepatitis B, an infection that leads to the development of the liver tumour. Liver cancer claims as many as 30 new cases per 100,000 in Southeast Asia every year,


Stop bad breath...
Fight tooth decay
Colgate
DENTAL CREAM
Colgate
STOPS BA
Here's how:
Odour- and decay-causing bacteria grow in food particles trapped between your teeth
Colgate's unique active foam reaches deep to remove dangerous food particles and bacteria
Result Fresh-breath confidence, protection against decay, strong healthy teeth
Colgate's trusted formula works to give you clean, fresh breath... strong, healthy teeth every time you brush.
Remember to brush with Colgate Dental Cream after every meal Stop bad breath fight tooth decay
You'll love its fresh minty taste!

MIND WARS



WITH APOLOGIES TO MORT WALKER ILLUSTRATION BY DHANANJAY

IMAGINE an estranged couple a continent apart The woman feels a sharp twinge of pain in the neck just as she is going to bed. "That must be Fred using his mind waves to hurt me" she mutters clenching her teeth.

That scenario is quite plausible, according to millions of enthusiasts of extrasensory perception (E S P). They believe in the power of mind over matter (in this case his mind over her matter). It is supposed to enable you to defy "normality" - to communicate mentally (telepathy), to see what exists beyond sight or time (clairvoyance) and even to move objects and cause events to happen - like tripping your mother-in-law and giving her a fracture (telekinesis)!

Indeed, belief in the potency of witchcraft and voodoo practices in the ability to harm or affect a person 'paranormally', is hardly new What is new is the willingness of the military to try the mumbo jumbo. Ronald McRae, a former investigative reporter for the columnist Jack Anderson, reveals in a forthcoming book the Pentagon's attempts at Close Encounters of the Third Degree kind which are costing the American tax payer $6 million annually.

The Pentagon has officially denied its involvement with the paranormal But sources like retired Lieut. General Daniel O Graham, former head of the Defence Intelligence Agency, recently told *New York Times* that the military had indeed been involved in a psychic research (although not to the tune of $6 million). The General said he would be surprised if they had not followed up on psychic weapons One reason for this could be the intense interest shown by the Soviets in this area Some "experts" equate the first strategic breakthrough in E.S P. defence with sole possession of nuclear weapons, reports *Time* which lists a number of bizarre sounding schemes undertaken by the military These include: sighting submarines by clairvoyance, sending signals by telepathy (for instance the physicist Russell Targ tried to transmit an image to a medium in California from General Grant's Tomb in New York City), using a "psychic" shell game to design a shifting MX missile system to confuse the Soviets. The U.S Army journal, *Military Review*, even featured a cover story on 'The New Mental Battlefield'.

One can speculate on any number of problems that are likely to arise while raising an elite E.S.P. corps. Here's just one example: Raw recruits endowed with E.S.P. will be extremely sensitive. Time honoured methods like drill and discipline may prove counterproductive to train and develop them Think of what a psychic Beetle Bailey or Sad Sack may *do* to a Sarge who breathes down his neck!

Also, how do you prevent misfire or mistakes in psychic warfare? For instance, I remember a character from Tintin comics, Marquis de Gorgonzola, interrogating a crusty old millionaire with the aid of truth serum and a psychiatrist Instead of spilling the combination to his safe, the millionaire keeps giving his captors the story of his life! Similarly there is every possibility of a psychic concentrating on a sensitive border landing in an equally sensitive bordello!

Nothing "concrete" (or shall we say 'spiritual") has materialised from these esoteric researches. But those familiar with Mughal history may get a feeling of *deja vu* in this matter: the ill-fated Dara Shikoh, heir to Shah Jahan's throne, was such a believer in matters psychical that he took along a mystic-cum-astrologer to a siege in Afghanistan Despite all imprecations, chants and charms, the siege did not succeed. The mystic was eventually taken hostage and killed by the rebels who refused to be "psyched"!

Is that the shape of things awaiting a psychic army?

Vithal C. Nadkarni

In West Bengal alone more than a thousand lives have been lost in a single month. All due to filthy contaminated water. This need not happen. Getting safe potable water at home is now within your reach

POTABLE WATER— Within our reach

EVEN before the advent of the monsoon, water-borne diseases have assumed frightening proportions in the country By the middle of May over 1400 people had died of bacillary dysentery in West Bengal, viral hepatitis B has claimed over 300 victims in Gujarat These epidemics are entirely man made for both hepatitis B and bacillary dysentery are due to poor sanitary conditions and bacterial contamination of water

Large tracts of sub-soil water in India are contaminated with worms, bacilli, amoebae and other disease causing organisms This situation further deteriorates with the onset of the rains And soon the water flowing from our taps will not only be muddy but will be swarming with unseen dangerous contaminants

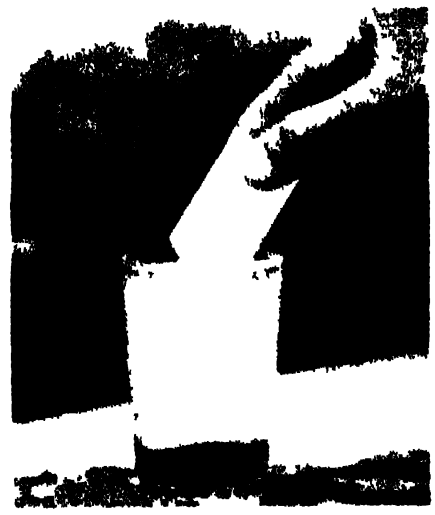
Ironically, the current decade (1981-1990) has been designated as the International Water Supply and Sanitation Decade by the United Nations The World Health Organisation has estimated that one in every three persons lacking clean water and sanitation is an Indian For 70 to 80 per cent of our population, clean drinking water is a pipe dream

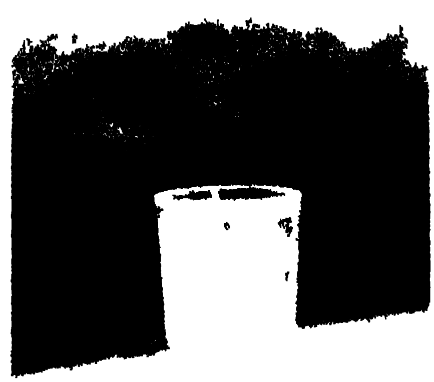
Water which is clean and safe when collected is not necessarily safe when it is consumed This is clearly revealed in the 1971-73 survey of five villages in Madurai, Tamil Nadu by the Gandhigram Institute People using street taps showed a higher incidence of diarrhoea and Shigellosis (a type of bacillary dysentery which hits children badly) than those having separate water connections This indicated that there was a high risk of water contamination during transport and storage

Of all water pollutants, natural chemical impurities are by far the least hazardous but man-made chemical impurities are often found to be toxic Human faecal wastes are dangerous too, because they indicate the presence of disease-causing organisms which cause water borne diseases

In India alone, over 50 million people get infected and more than two million die annually of water borne bacterial diseases such as typhoid cholera and dysentery Also, viral diseases like infective hepatitis (jaundice), polio and protozoan diseases like amoebic dysentery are almost exclusively water-borne Other helminthic or worm infections caused by roundworms whipworms and guinea worms fall in the same category

Now the question which naturally arises is How do we make the most of the available water supply? Should we distil, filter or boil the water? First let us understand the nature of the problem





What contaminates our water?

In villages the main water sources are wells, lakes, stagnant pools, mud holes, springs and tiny cracks in the rocks Needless to say, certain unhygienic practices contribute to the deterioration of

What's available?

IN India, the demand for water filters is growing at the rate of about 15 to 20 per cent, which translates into one lakh pieces a year. At present, many different brands of domestic filters are available in the Indian market. Most of these are candle filters, consisting of two compartments placed one over the other. The upper compartment generally contains the candle/candles and the lower one contains the filtered water. Four types of models with varying capacities are available. Generally, the 11 to 13 litre models have a single candle, the 18 to 20 litre models have two candles, the 27 to 30 litre models have three candles and the 36 to 42 litre models have four candles. The containers are generally of aluminium, coated with a scratch-resistant material, or are of stainless steel or plastic, and vary in price accordingly. For some brands a choice of colours is available. The brands of microfilters are also available alongwith a brand of microporous filter. A tablet for sterilising water is also marketed now.

WELOFIL WATER FILTERS come in four sizes and colours as mentioned above. The containers are made of aluminium alloy sheets. The unit is light, portable and unbreakable and has a protective rubber base provided. A soft plastic brush for cleaning the candles is supplied with the unit.

AQUAWELL FILTERS come in five models the four sizes mentioned above and a *matka* filter. The containers are made of stainless steel. "Burkfilt overcoats", which can be slipped over the filter candle to keep it clean and to prolong its life, are also marketed. The overcoat is removable and washable.

VEELINE WATER FILTERS and MAJESTIC WATER FILTERS have polypropylene filters and plastic containers.

CONCORD WATER FILTERS are the first filters with a water level indicator to be marketed in India.

Other commonly available filters are PURITAS FILTERS, BAJAJ FILTERS, ANJALI FILTERS and DASWANI FILTERS.

Two brands of microfilters are available. These are small units, which can be directly attached to the tap to provide instant potable water.

SWAN MICROFILTERS have an inlet pipe which can be attached to the tap. The filter cartridge is hermetically sealed and the water flows upwards (due to pressure) through the filter and into the outlet pipe which is attached to the top of the filter. The filter cartridge is replaceable. Unit is small and made of plastic. The candle is 25 cm long.

WELOFIL MICROFILTER contains a cartridge impregnated with formaldehyde.

One brand of microporous filter is available.

PHIROL MICROPOROUS WATER FILTER is a small plastic unit which should be filled with moist cotton and connected to the tap.

Now-a-days, tablets for pure and safe drinking water are available in the market—STERITABS come in five strips of 10 tablets each in a box. Each tablet contains 25 milligram of sodium dichloro S-triazinetrion. As soon as the tablet is dropped into water, effervescence occurs. According to the instructions on the strip, purified water is not to be stored in stainless steel, copper or brass containers. The manufacturers claim that steritabs provide pure, safe germ-free drinking water. Also, they help prevent water-borne infections–amoebic dysentery, diarrhoea, typhoid, cholera and jaundice.

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water. For instance, in villages it is a common practice to bathe,wash clothes and utensils close to the source of water supply The dirt and infectious agents that are washed away percolate through the soil and enter the water source thereby contaminating it.

In cities and towns, water supplied by the municipality is treated, but by the time it reaches the consumer, it gets contaminated. Reservoirs, pipelines and storage tanks may not be cleaned sufficiently or regularly or may be tampered with Often sewage and water pipes lie adjacent to each other resulting in the mixing of waters. Rust and dirt mingle with disease-causing agents in the water pipes and very often this unwholesome brew gushes out of the household tap

During the monsoon, the problem of discoloured unhygienic water supply becomes even more acute. Rusted pipelines burst, neglected reservoirs develop cracks and sewage seeps through the soil to ground and surface water supplies. Also, during the rains, people are under more stress having to cope with the inclement weather. Consequently, their resistance to disease is lowered and there are often epidemics during the wet season. Rain water,which ultimately becomes our drinking water, contains traces of all the pollutants present in the air - dust particles, ash, soot, traces of salts and upto a dozen identifiable organic compounds. When it collects in lakes or wells, it further acquires dissolved fertilisers and other soluble chemicals as a result of agricultural run off, industrial effluents and urban wastes.

What precautions should a housewife take to guard the family against water-borne diseases? To deal with the problem effectively, it is necessary to realise that water being a universal solvent is never completely pure.

Home-treatment for water

Absolutely clean domestic water supply is a myth in the Indian context. However, a housewife can use a few simple home-remedies to make the water safe and potable. Water can be safely disinfected by stirring a crystal or a block of alum, two or three times on the surface of water,stored in a bucket. Alum, a double-salt-sulphate, coagulates the impurities along with the bacteria and settles the mud. The coagulated matter sediments down clearing the water. A few crystals of potassium permanganate can be added to water before using it to wash vegetables and fruit. Being an oxidising agent it acts as a splendid germicide and prevents spoilage of vegetables and fruit on storage.

A popular method of water purification used by housewives is filtration. Filtration is an old concept. Traditionally, water was filtered for domestic use by passing it through three pots containing gravel, charcoal and sand respectively. Even now, women in rural areas use this technique which, though crude, is effective in removing coarse suspended impurities from water. It does not disinfect the water however.

Filters that are currently marketed fall into two categories—those that can remove particulate matter and those that can remove both particulate matter and micro-organisms. The latter are known as bacteriological filters. Small, handy microporous water filters that can be attached to a tap are also available. These filters are layered with moist cotton before attachment. They merely block the flow of large particles suspended in water but cannot retain bacteria and so are not bacteriological filters.

Bacteriological filters are of various kinds but those designed for domestic purposes are basically of two types—candle filters and membrane filters. The action of these filters is to retain micro-organisms.

Candle filters are made either of diatomaceous earth or unglazed ceramic. Their mode of action is to retain dirt and micro-organisms in their pores. If the pores are choked, the rate of filtration will slow down. So it is essential to clean the candle regularly. If a filter has not been used or cleaned for a long time, high bacterial levels are likely to be present, and the filter can become a health hazard under such conditions.

Tested filters

THE Consumer Guidance Society of India (CGSI) tested filter candles twice in 1980 and 1981 to test the manufacturers' claims. The following brands were tested: PUREX, PURITAS, WELOFIL, SUDARSHAN and BAJAJ.

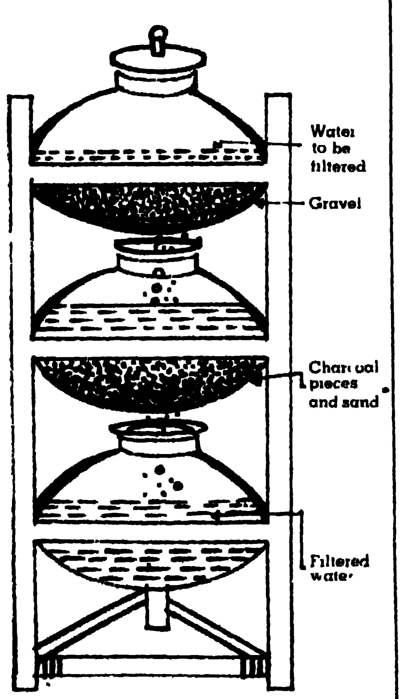
According to the CGSI, filters passed both the sets of tests. Sudarshan filters have candles which are impregnated with silver chloride. These filters yielded sterile water and the silver chloride did not enter the filtered water.

Purex, Welofil and Bajaj candles did not retain bacteria completely and so were 'not suitable' for sterilisation of water. It was also found that the candles used in Puritas, Welofil and Bajaj filters are manufactured by the same company and supplied to these firms to be marketed under their brand names. Other brands of water filters have not been tested.

Another type of bacteriological filter is the membrane or molecular filter. These filters contain porous discs of biologically inert esters. Membrane filters are used in the form of cartridges which must be replaced once saturated.

How long does a domestic bacteriological filter remain usable? There are no hard and fast rules, but, broadly speaking, a candle filter should be replaced when the candle gets reduced in width by about 2 cm. Actual lifetimes of different types of filters vary greatly, depending on the local water quality and the amount of water filtered per day. The more polluted the water supply, the shorter the lifespan of the filter candle or cartridge. With respect to the amount of water used, it can be approximated that typically about 18 to 20 litres of water are used per day for cooking and drinking in an average household. Upto 270 litres of water can pass through a candle filter before it needs cleaning. This means that at least once a fortnight, the candles in a candle filter should be cleaned under a running tap, brushed with a soft brush until their colour is restored and then rinsed thoroughly. The containers of the filter should be washed thoroughly too. Once every three months, the candles should be soaked in water for about 15 to 20 minutes and then immersed in boiling water till the water cools. This destroys the micro-organisms that are entrapped in the pores of the filter, and so sterilises it. If properly maintained, a candle can be effectively used for upto three years.

Simple household filter



A membrane filter should be cleaned and the cartridge replaced according to the recommendations of the manufacturer, because different membrane filters vary with respect to sizes of the pores and pore distribution. These two factors and the amount of water filtered determine the lifespan of the cartridge.

Activated charcoal filters are used to remove large and malodorous particles from water. They are used to remove the residual chlorine in water which gives out a typical odour. These filters, however, are not bacteriological filters. In fact, they are unsafe for use if not cleaned regularly, since activated charcoal is a fairly good medium for bacterial growth. Domestic filters containing activated charcoal are not marketed in India.

A major drawback of filters is that, though they render the water free of both particulate matter and bacteria, they cannot destroy or eliminate certain unfilterable viruses. Because viruses are very much smaller than bacteria. Viruses range in size from 10 to 300 nm (nanometres) whereas bacteria vary between 50 and 5000 nm. These viruses are responsible for a range of infections including infective hepatitis (jaundice) and gastroenteritis and can be destroyed only by boiling the water. Besides, boiling also destroys those micro-organisms that have somehow managed to pass through the filter. To ensure that your drinking water is absolutely safe, it must be filtered and boiled.

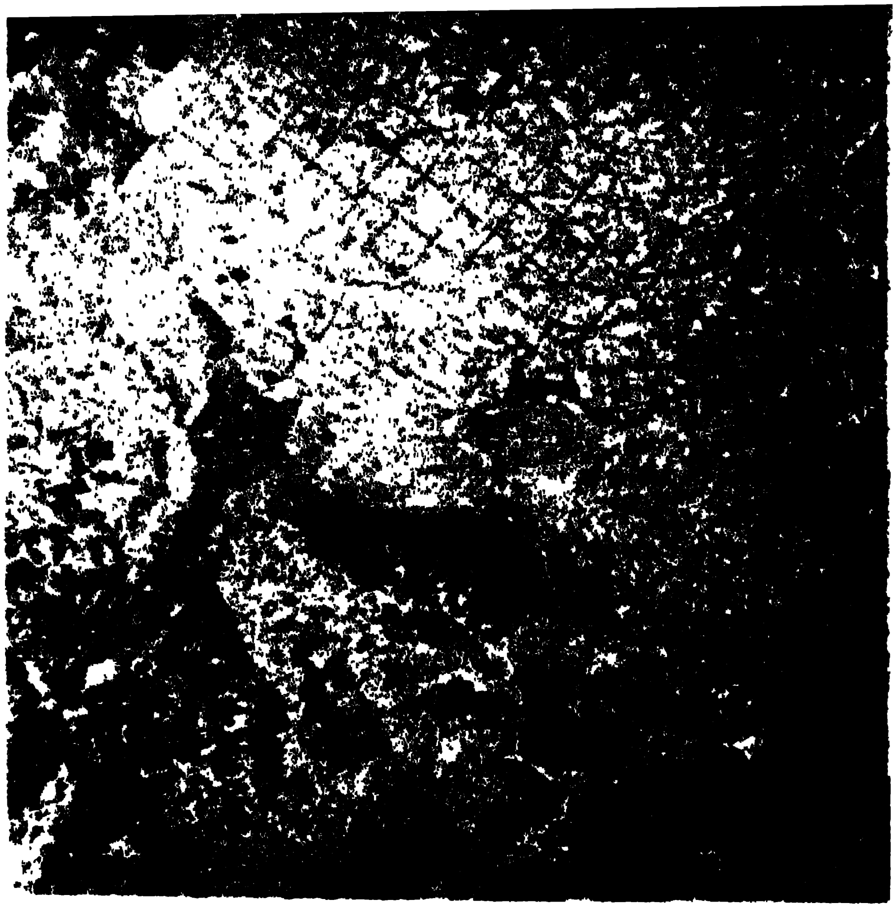
Another problem that the housewife often faces is that of dealing with excessive chlorination. Chlorine is present in water treated at municipal water purification plants. Ten minutes after treatment, levels range from 0.2 to 0.8 parts per million (ppm) over a pH range of 6.0 to 9.0. These levels are adequate to destroy all pathogens, to inhibit the growth of algae and weeds, and to oxidise certain inorganic impurities like hydrogen sulphide, and ferrous and manganous salts. However, it cannot destroy the cysts of the amoebic dysentery organisms. Though chlorination has reduced the incidence of water-borne diseases, in excess, it creates problems. For instance, several studies have linked increased cancer mortality with chlorinated surface water. It is thought that chlorine reacts with certain organic compounds naturally present in surface water to form health-threatening products. One of the known products, chloroform, has been found to cause cancer in laboratory animals.

A new method of purification has been discovered recently which requires the use of the horse-radish tree (ben-nut tree), which grows in our country. The seeds of this tree are to be chopped up, wrapped in cloth and the bundle twisted in water for 20 to 30 minutes. About 0.17 gm of seeds is adequate to purify one litre of water. The mucilage of another local herb known as Peru tuna cactus can also be used to purify water.

The use of clay slurry to cleanse water is common in countries like Sudan. It involves the addition of a few grammes of clay sediment collected from rivers. Initially the clay is stirred from a smooth paste to one with a liquid consistency. Purification is time-consuming but effective due to the presence of a substance in the clay. Besides this, ground rocks and surprisingly earth from anthills are used to purify water and make it potable.

Reports on newer and better methods of water purification keep coming in. In days to come women may even build themselves solar water purifiers which will supply them with potable water directly from the tap with the Sun's blessings.

Gillian Valladares
Parul R. Sheth

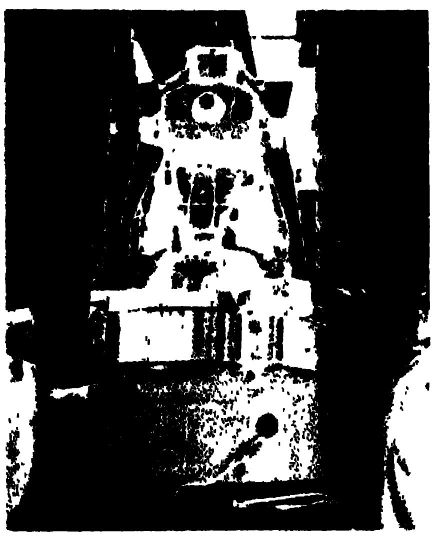


Development of Eastern Hokkaido, Japan.

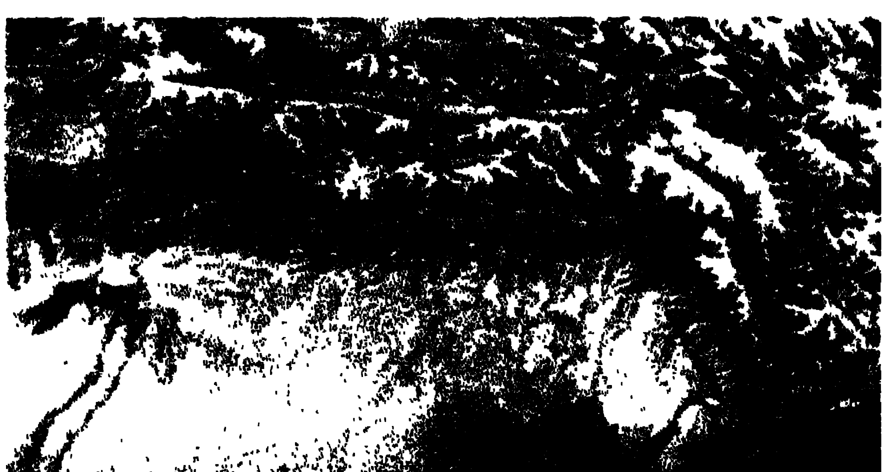
EARTHSCAPES

With Man's great leap outward in space, the planet Earth seems to have suddenly shrunk. How fragile (yet tenacious) is its biosphere, how finite its resources and how extensive are the changes wrought by Man, these perspectives can be seen vividly by satellite, by the study of images captured by the Landsat spacecraft. We present a fascinating review of a magnificent book of global geography

SATELLITES, are more than just artificial moons of the Earth. They are vehicles of the communication revolution — instruments to draw the whole world together into one global village linked by transcontinental telephone and television signals. Although they can be used for short term cloud pictures and long range weather forecasting, satellites are also employed for spying on alien territories and to snoop on military installations. A less well-known group of satellites are designed to photograph the land and oceans of our planet. These are the Earth Resources Tracking Satellites of the ERTS series later renamed Landsat. They provide pictures vivid enough to arm us with information on minerals and



Satellite with technicians.
The Takla Makan Dessert and K2 . ▶

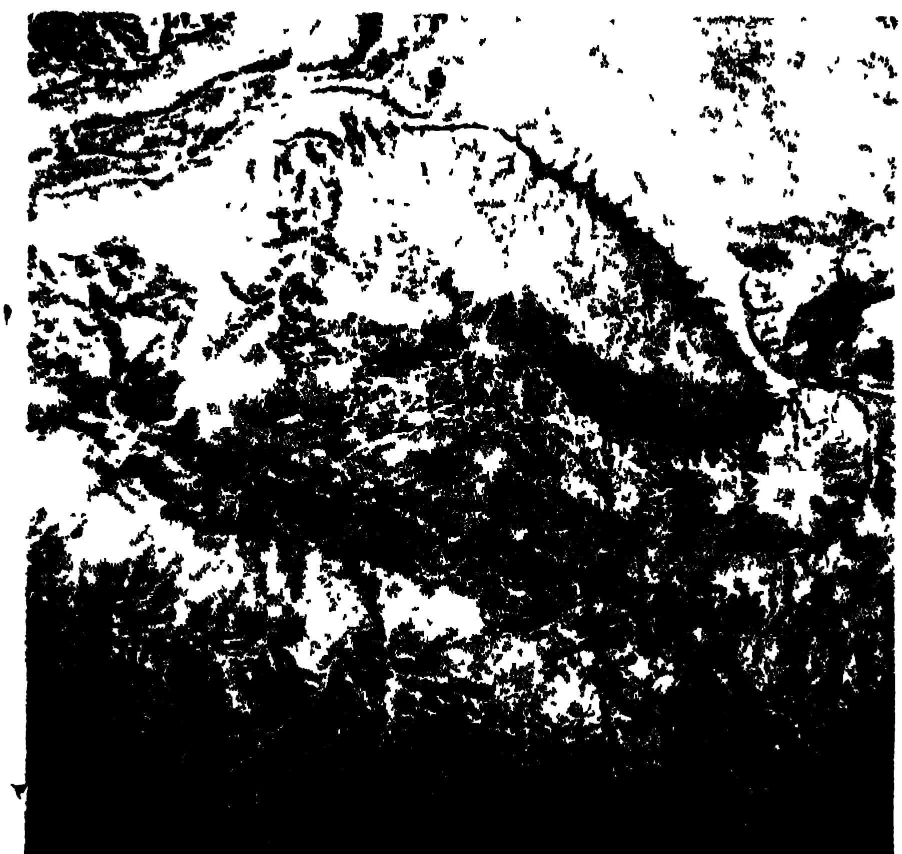


valuable energy resources, ground water and food and fibre.

Between 1972 and 1982 four Landsats were launched by the US. Of these only Landsat-4 (*see picture*) is now operational. Flying at a height of 917 kilometres it transmits to earth more than a million separate items of information every second. Roughly an area of 10,000 square kilometres is covered in the time that it takes to read this

SCIENCE TODAY MAY 1984

"Man on Earth, The Marks of Man: A Survey from Space". By Charles Sheffield; Published by Sidgwick and Jackson, London. Price: £ 12.95



Bathurst Island, Canada.
Uranium in San Rafael Swell, Utah.

sentence and a single Landsat scan covers 33,000 sq. km.

Landsats are unique, because they are equipped with sensors which can detect reflected sunlight from the surface features of Earth, as no human eye can. This is because the imaging system scans two wavelengths in the infrared region in addition to the red and yellow wavelengths from the visible region. After computerised processing, the images are equipped with 'false colours' to make them meaningful to the human observer.

The saga of the Landsats is now vividly brought out by Charles Sheffield, Vice-President of the Earth Satellite Corporation in his book "Man on Earth". He has not only packed the book with a large number of breathtaking pictures (made available by Landsat), but in interpreting these, he provides a lucid explanation of the working of the satellite as well as the method of interpretation. For example, the 'false colour' images have their own colour lexicon. The larger infrared is usually shown as red, true red as yellow and true yellow as blue. Naturally, crops and other vegetation appear as shades of red, urban areas as grey or grey-blue, clear, deep water as black and so on. Once this initial confusion is overcome however, the pictures literally speak for themselves and present us with a wealth of information For instance the polished marble slab in the picture of Bathurst Island in the extreme north of Canada (*see picture*) represents shale, covered with a layer of moss and lichen. This is an immediate indication of oil and gas underneath Even with respect to the population on the developing Eastern Hokkaido Islands, Japan (*see picture*) and the unpopulated, mystic Himalayan peaks overseeing China and India simultaneously (*see picture*)

Sheffield's "Man on Earth" is not just a compendium of colour plates. It is a chronicle of man's achievement, at once making us proud and humble.

Bal Phondke

Monsoon maladies

Rehydration drink to prevent and treat dehydration In 1 litre of water (1) (better if boiled, but do not lose time) put 2 level tablespoons of sugar (2) or honey and ¼ teaspoon salt (3) and ¼ teaspoon baking soda (4) (bicarbonate of soda) If soda is not there, add another ¼ teaspoon salt. Also add half a cup of orange juice or coconut water or a little mashed ripe banana to the drink, if available.

DOCTOR the monsoon is fast approaching I understand that several diseases especially water borne diseases, afflict a large number of people in this season Is it true?

Yes that's true Gastroenteritis is the most common disease which flares up in the monsoon followed by typhoid dysentery cholera and infective hepatitis

Doctor what's gastroenteritis?

Gastroenteritis is an inflammation of the lining of the stomach and small intestine

Which specific bug causes gastroenteritis? And are there medicines to kill these bugs?

I am afraid it is not a single bug, as you call it which causes gastroenteritis Several bacteria and viruses and even endotoxins (the toxins of certain bacteria) cause gastroenteritis Whereas many of the bacteria respond to drugs, there is no way of destroying the endotoxins and viruses However if we treat the symptoms of gastroenteritis very energetically, almost all the patients of viral gastroenteritis and also many cases of endotoxin gastroenteritis recover

What are the symptoms of gastroenteritis?

The person will develop pain in the abdomen, accompanied by vomiting and diarrhoea (loose motions), and very often fever

What can we do to prevent this disease?

First of all, never eat anything bought at the roadside from hawkers Even in good hotels, it is best not to eat the salads or cold meats and order only piping hot food In your own home, wash all the vegetables, salads and fruits thoroughly under running water or use potassium permanganate solution which is even better for this purpose All cooked food should be kept covered and protected from flies. Drinking water should

Gastroenteritis, typhoid, dysentery, cholera and infective hepatitis flare up every monsoon. The cheapest and most effective answer to the problem is simple rules of basic hygiene, scrupulously followed

be boiled. The kitchen refuse pail must be kept covered so that it does not attract flies.

Oh! so flies are the mischief-makers ...

Not only flies, but the mixing of sewage and drinking water is responsible for the spread of this disease. The excreta of infected patients are carried by flies to food. In a similar manner, sewage water carrying infected matter may contaminate drinking water particularly during heavy rains or when the pipes burst. Uncontrolled proliferation of slums particularly near large water storage tanks or near the lakes which supply different parts of the city with water, are a terrible public health hazard, because night soil from these shanty towns have an easy access to drinking water sources.

What is the treatment for this disease?

In the acute form, it is advisable to have bed rest and to completely abstain from food. A moderate fluid intake is permissible when the nausea subsides. Antispasmodic and antacid drugs and some other drugs to quiet the excess intestinal activity and to halt the diarrhoea can also be taken.

How soon do people with gastroenteritis get well?

The condition usually subsides within one to three days. If it does not, pathological examinations should be carried out to determine the possible existence of some more serious underlying causes.

How does one distinguish between the acute inflammation of the stomach and that of the intestines?

The latter condition. is accompanied by violent mid-abdominal and lower abdominal cramps, with episodes of diarrhoea When the stomach is involved, diarrhoea is not present.

Is dysentery something like gastroenteritis?

Well, yes and no. A patient suffering from dysentery has severe diarrhoea with blood and mucus in stools. There is usually no vomiting.

Is it also caused by more than one agent, like gastroenteritis?

Yes, there are two main organisms which cause dysentery in India. One is a bacterium, *Shigella*, which causes bacillary dysentery. The second is a protozoon, amoeba, which produces amoebic dysentery. Clinically, they present a very similar picture but examination of stool samples reveals the true culprit. This is important, because the treatment for each is different.

What is the treatment? I understand, that the doctors always prescribe drugs like Mexaform and Enterovioform for diarrhoea and dysentery.

Mexaform and Enteroviotorm are anti-infective drugs containing quiniodochlor and are to be taken only when one has got amoebic dysentery. I am aware that most of the doctors blindly prescribe these drugs whenever there is any gastronomical upset. Very few of them resort to stool examination which does not even take five minutes to ascertain the cause of dysentery.

And I understand that Mexaform, etc have been banned in Japan, Europe and in the West...

You are right. In these countries, these drugs are banned. But you should not forget that indiscriminate and long-term use of any drugs can have side-effects. Mexaform and Enterovioform were used rather indiscriminately in Japan and in European countries—on an average for three to six months by the people and, not surprisingly, they experienced blindness and neurological problems. Used carefully and under medical supervision there is no need to worry while taking these drugs. In medical jargon, these symptoms are called sub-acute-myelo-optic neuritis (Smon), characterised by inflammation of the spinal cord and the optic nerve.

Are there any Smon patients in India?

To date, 12 cases with Smon-like symptoms have been reported in India. The number is indeed small, considering the way these drugs are sold over the counter in India, but still it is not advisable to take them unless amoebic dysentery is confirmed and you are under medical supervision.

But doctor, the same Mexaform and Enterovioform are even sold by the banias *in our slum-areas. My servant once came down with loose motions and, my inquiries revealed that she had just swallowed these 'khaki'-coloured tablets bought from a local* bania.

Yes, I am aware of these things. But as I said, these quiniodochlors are only effective for amoebic dysentery

So what medicines does one take for dysentery?

For bacillary dysentery, antibiotics (chlor amphenicol and streptomycin) are normally given. The full course of the antibiotic must be completed, otherwise one runs the risk of developing resistance to the drug. In fact, the bacterial strain causing dysentery has already developed resistance to streptomycin and hence streptomycin is not effective in curing diarrhoea due to dysentery.

But doctor, recently my sister was given antibiotics, Enterovioform, Lomotil and what not for diarrhoea....

What you are talking about is 'shot-gun therapy', especially given in acute cases of diarrhoea. The doctors do not want to take a chance and hence prescribe all the above drugs.

But Lomotil? Isn't it banned too?

Lomotil controls excessive motility of the bowels. Given in proper dosage it is safe. However, it is not recommended for children for it has an opium-like effect on them and makes them drowsy, especially if taken in excess. Additionally, toxic products of the stool remain in stomach and this also produces toxicity in children.

Why do doctors always advise intake of lots of fluids during gastroenteritis, dysentery, etc?

Loose motions, especially watery stools can lead to dehydration—the loss of body fluids. To compensate for this fluid loss, lots of water in any form—coconut water or lemon-barley water or just plain water with one tablespoonful of sugar and half a teaspoonful of common salt—is recommended. Better still is 'Electral' or 'Staminade'. These powders contain important electrolytes (salts) like sodium, potassium, magnesium, calcium, etc which replace the salts lost by diarrhoea patients. These salts must be replaced, otherwise, dehydration, especially in hot weather can lead to serious complications.

Doctor, what is this ORS mixture one hears about so much these days?

Oral rehydration salt (ORS) solution is recommended as an effective first treatment for the loss of fluids and electrolytes during diarrhoea. It is available as a pre-packed mix which is to be dissolved in water before drinking.

But the home treatment of adding salt and sugar to water (as described above) is just as effective- it costs nothing and doesn't require manufacturing, packaging and distribution networks This home treatment needs to be more intensively promoted, for it will avert millions of deaths due to diarrhoea

Doctor, I also read somewhere that this ORS mix does more harm than good?

That's only when the water used for dissolving the mix is contaminated. It is absolutely necessary to decontaminate the drinking water before adding the ORS mix. Otherwise, the mix will further support the growth of enteric bacteria present in the water. Placed as we are, I would recommend the use of home remedy as an effective first treatment for dehydration.

Sucharita A. Nanivadekar

Dr Nanivadekar is Professor of Medicine at the L.T M G Medical College, Bombay.

Even small amounts of vanadium makes steel harder, yet more ductile

Resources for tomorrow

THE **VITAMIN** METAL

M. A. Nabar

WE all know what vitamins are. They are those wonderful chemicals which are needed in tiny amounts but without them there will be no strength left in the body. But this phenomenon is not restricted to living beings. In the inanimate world of metals too, addition of certain elements, even in minuscule concentrations, can radically alter the strength of metals. Vanadium is such an element which helps steel overcome its weakness. It is therefore rightly called as the vitamin metal. Vanadium steel has brought about a virtual revolution in the automobile industry.

Discovery

The discovery of Vanadium, however, makes a very interesting reading for it had eluded identification for well over 30 years. Andres Manuel del Rio, a freedom fighter, chemist and professor of mineralogy at the University of Mexico recognised in 1801 the existence of a new element in a lead ore from Zimapan. He named this as 'panchronium' or 'erythronium', owing to its capacity to form numerous coloured compounds.

Nonetheless, he could not support this claim on further investigations and felt that he had committed a mistake. He concluded that the mineral was basic lead chromate. Thirty years later, metallurgists of the day were intrigued with a curious finding. Metal smelted from iron ores that came from certain deposits was found to be brittle while that coming from certain other deposits was free from this drawback. A Swedish scientist Nils Selfstrom set out to solve this mystery. In collaboration with Berzelius he was able to prove that the ores which gave the high grade metal contained a new element. The element was given the name Vanadium after Vanadis, the legendery goddess of beauty. The richness of the colours which the derivatives of vanadium possessed attracted Wohler to this new metal and it was he who demonstrated that del Rio's panchromium was actually vanadium.

Ores and Minerals

The characteristic properties of vanadium known from the very beginning, as well as the circumstances of its discovery, aroused considerable interest. The greatest contributor to the chemistry of vanadium was Roscoe, who published a series of papers, about copper ores mined in Cheshire and was the first to obtain the metal in pure form in 1898. It still contained, however about 4 per cent impurities.

Vanadium has about 0 02 per cent abundance in the earth's crust. This level is by no means low since it is about 15 times more than that of lead and 2,000 times that of silver. Further, it is fairly widespread, there being 65 minerals known, one of which is roscoelite known after Roscoe. But there are only a few concentrated deposits, and only rarely as vanadium deposits proper! During primary crystallisa-

The diverse uses of vanadium range from the manufacture of special hard steels to making of a reusable photographic developer

tions, vanadium accumulates mainly in the so called final phases of gabbroid rocks like titanomagnetites and pyroxenes. Vanadium is also scattered in metasilicates and sulphides. It is encountered together with phosphorous and also with substances of organic origin. Interestingly enough, it is encountered in ferrous sedimentary rocks, in some coals, asphalts, bitumens and in petroleum. The meteorites which hit the earth contain much more vanadium than earth's crust. The solar radiation spectrum also contains a number of vanadium lines supporting the suspicion that there must be richer deposits in our galaxy.

Another interesting ore is constituted by petrified plant residues which possess sorbed vanadium salts. This element was identified in the bodies of a variety of plants and certain sea animals like sea urchins, ascidia and especially sea cucumbers, whose blood contains as high as 18.5 per cent vanadium. Vanadium is thus seen to be a biologically important element, owing to its catalytic activity. Scientists, in fact, have been trying with the idea of extracting vanadium by using marine animals. The Japanese have started having plantations of ascidians along their sea coast. This 'live' ore contains vanadium in a concentrated form and hence extraction might prove to be somewhat easier. The more important minerals of vanadium are patronite, vanadinite, carnotite, roscoelite, mottramite, descloisite and tynyamunite.

Metal purification

The United States is the largest producer and consumer of vanadium, the bulk of the output being a by-product of accelerated uranium production programme. It continues to be a coproduct of the carnolite, uranium containing ores of Colorado, which contain 1 to 2 per cent vanadium. The only other leading producers of vanadium in the Western world are Finland and South Africa, although several other potentially recoverable deposits are known to exist in Northern Rhodesia, Peru, Venezuela, France and in Katanga.

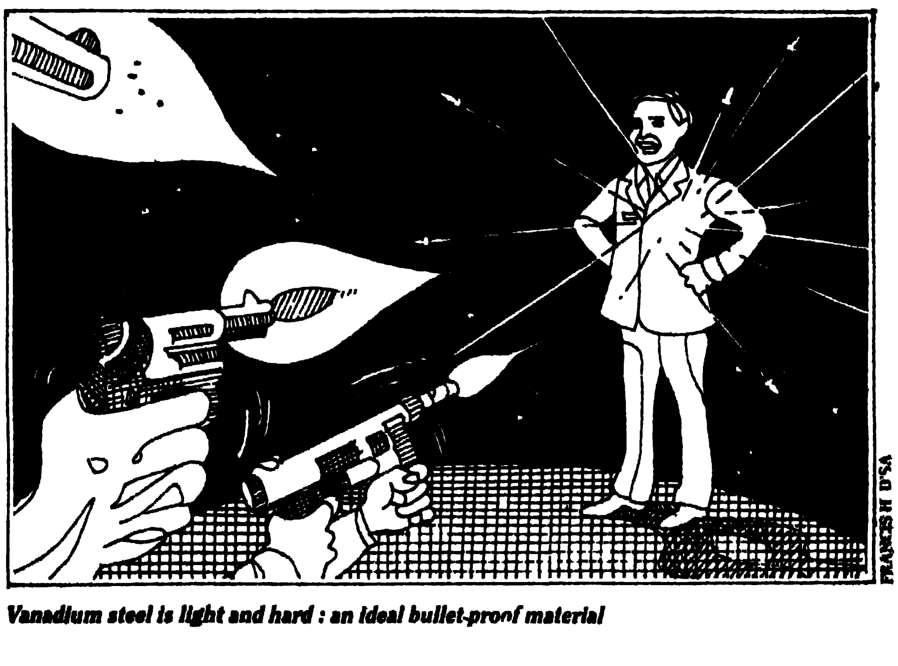
The variable constitution of vanadium ores is responsible for the variety of the procuring methods. The common objective, however, is to obtain some intermediate compound say a pentoxide, V_2O_5 or a vanadate which is then processed to ferrovanadium for steel industry or to pure vanadium compounds and to metallic vanadium. The pure metal is very difficult to prepare, principally because it combines readily with carbon, hydrogen and nitrogen. The principal general methods for the production of pure metal are reduction of either chlorides or oxides and the thermal dissociation of di-iodide, the latter method yielding more than 99.5 per cent purity. It is also possible to produce very high purity (nearly 99.99 per cent) metal by electrorefining.

Special properties

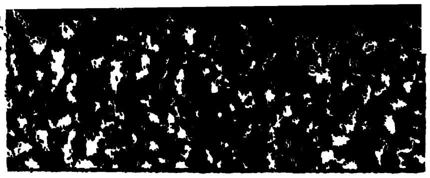
The greyish-silvery pure metal is both malleable and ductile and can be cold-worked into a foil. However, even small amounts of certain impurities such as hydrogen (less than 0.01 per cent) can cause embrittlement and modify other properties significantly. The metallic vanadium has thermal conductivity similar to that of iron. It is light with a density intermediate, between that of titanium and iron. This property had helped the French during World War I to carry a field-gun aboard an aeroplane instead of the usual machine gun. The Germans were naturally quite agitated.

Notwithstanding its lightness the metal is pretty hard. The hardness has been variously estimated to be 5 to 7.5, the lower limit being probably more appropriate for pure metal. This combination of lightness and hardness made vanadium steel an ideal material for making soldiers helmets and armour. Their weight was bearable and yet afforded excellent protection from bullets and splinters. The metal has good structural strength and a low absorption cross section for fission neutrons which are responsible for its use in nuclear technology. The metal is also used in producing rust-resistant springs and high-speed-tool steels. Vanadium has good corrosion resistance to salt water, to air at ordinary temperatures and to some acids as well as alkalies.

Vanadium is an element of exceptional importance in modern technology. Its greatest uses are in the production of special steels, since it has



Vanadium steel is light and hard : an ideal bullet-proof material



The future of vanadium in India is closely linked to the revolution taking place in the automobile industry

unlimited solubility in alpha-iron. Its pronounced tendency to carbide formation makes vanadium a beneficial additive in steels. In its presence the structure of steel becomes fine grained and uniform, increasing the ductility and also improving mechanical properties such as hardness. These are exactly the properties which make vanadium steel eminently suited to the needs of automobile industry. It may also act as an antioxidant, reducing the solubility of oxygen in steel. Cast iron containing vanadium enhances its tensile strength enabling its use for the manufacture of rolling-mill rolls, dies for cold punching and other machine parts. Vanadium is also a constituent part of a special steel for the production of permanent magnets containing on an average 10 per cent vanadium, 50 per cent cobalt and 40 per cent iron.

The high corrosion resistance permits use of some vanadium-copper alloys for making machine parts like propellers for ships in sea water. Vanadium bronzes are used for certain key parts of machines and hard vanadium-gold alloys in dental surgery.

Owing to the advances made in the production technology of malleable vanadium, the metal and some of its alloys are now used as structural material. It is particularly useful for nuclear reactors, owing to its high melting point and resistance to certain melts. On the other hand, vanadium acts as a sort of solvent for uranium facilitating melting of the latter This allows easy formation of uranium-vanadium alloys. Consequently in certain type of reactors requiring molten uranium, vanadium has proved to be an invaluable asset.

Compounds

Vanadium forms numerous classes of compounds because of its ability to exist in many oxidation states, to serve either as a metal or a non-metal. Among these compounds of vanadium the brick-red pentoxide (V_2O_5) is the most important one. The pentoxide loses oxygen reversibly in the region of 700° to 1125° C a phenomenon which may account for its catalytic properties. It is well known, that this catalyst has replaced platinum in the contact process for the manufacture of sulphuric acid, the key heavy chemical of all chemical industry. This is not only because vanadium is cheaper but also because it is not poisoned by arsenic for the oxidation of sulphur dioxide to trioxide. It also catalyses the sulphonation of aromatic hydrocarbons, or pyridine or naphthalene and its substitution products by air and the reduction of aromatic hydrocarbons by hydrogen. It has been recently shown that both the single crystal and molten V_2O_5 possess peculiar electrical conductivities prompting their possible use as a semiconductor.

Certain oxo-vanadium species, particularly vanadyl sulphate, find an important use in analytical work as a reducing agent. Ammonium orthovanadate gives a sensitive test for cocaine and other alkaloids containing benzoic acid groups. It is thus finding increasing use in forensic science.

Vanadium compounds impart colour to glass. The light absorption by the glass varies in accordance with the relative proportions of tetra-and pentavalent vanadium. The colour of the glass is yellowish-green if this ratio is 0.5 and turns to orange-yellow when it falls to 0.2. These properties have led to vanadium being used for protecting the eyes from 'actinic' rays (0.2 per cent vanadium cuts out all wave lengths below 3580 A). It is therefore included in eye glasses, show windows, house window-panes and for avoiding deterioration of nitrocellulose in plastic layers of safety glasses.

Vanadium salts have been recently used in medicine too, though in minute quantities (0.00025 g of V_2O_5 in dilute solution not more frequently than a twice a day) because of their oxidizing and stimulating effect and also as an antiseptic. Vanadium salts stimulate plant growth and their use as a trace metal in fertilizers is suggested. Some experiments in Argentina have shown that inclusion of vanadium in pig's feed helps enhance their appetite and makes them gain weight fast. Vanadium compounds are, however, toxic, the maximum permitted quantity of V_2O_5 dust in air being 0.5 mg/m³ and of V_2O_5 fumes, 0.1 mg/m³.

Finally it is needless to say that vanadium salts are used as a constituent of pigments, particularly in printing inks. A solution of ammonium vanadate and gallic acid is known even from the days of Berzelius. They are used as a dryer in paint and varnish industry, and also in dyeing processes as catalysts as well as mordants. In the dyeing process, the vanadium salts reduce the catalyst cost enormously as against the till recently used copper salts. In photography, vanadium pentoxide is used as a 'perpetual' developer. For this purpose it is dissolved in sulphuric acid, diluted with water and reduced by zinc. This developer can be easily revived by reducing it again with zinc.

Indian Scene

Development of vanadium mining in India is almost non-existent. One of the reasons being the poor availability of significant deposits. The little quantity of vanadium that is available is as a by-product in the uranium as well as aluminium processing. The Uranium Corporation of India Ltd as well as the Atomic Minerals Division now have ongoing programmes for purification of vanadium. Laboratory research is also being conducted at the Bhabha Atomic Research Centre. Another possible reason for the indifference to this important metal is perhaps the lack of prospective application in the existent industry. The major user of vanadium even in the developed countries is the automobile industry. Recently, the latter has been showing signs of undergoing a virtual revolution in India. It is to be expected that this should act as a tonic for this vitamin among metals. The very recent finding of placer deposits of ilmenite containing as high as 0.5 per cent vanadium along the Konkan coast in Maharashtra should provide further fillip in this direction. □

Prof. Nabar is Head of the Department of Chemistry, Bombay University.

WHAT'S IN A NAME?

FOR this month's quiz we return to scientists. If you remember, we had earlier set a quiz on "giants immortalised in the annals of science (Of Bose and Bowman, January 1984)". This month's quiz is as biographical as it is scientific. The 10 terms given here all have their origins in names—usually that of their discoverers. Choose the best alternative given with each, and see how much you know about them. Answers on pages 72, 73.

(1) Pasteurise:
(A) To remove butter from milk.
(B) To sterilise, using heat.
(C) To filter.

(2) Galvanise:
(A) Coat with zinc.
(B) To charge batteries.
(C) To collect something.

(3) Angstrom:
(A) Unit of length.
(B) Unit of speed.
(C) Unit of optical intensity.

(4) Wattage:
Describes amount of power. It derives from the name of a—
(A) Scottish engineer.
(B) German scientist.
(C) Swedish physicist.

(5) Fallopian tubes:
Name of tubes connecting—
(A) Ovaries and uterus.
(B) Heart and lungs.
(C) Kidneys and bladder.

(6) Magellanic:
Describes—
(A) A large body of water.
(B) Deep sea.
(C) A galaxy.

(7) Vulcanise:
Method of treating—
(A) Oxygen.
(B) Rubber.
(C) Wood.

(8) Daltonism:
(A) Generally accepted atomic theory.
(B) John Dalton's philosophy.
(C) Form of colour blindness.

(9) Braille:
(A) By ancient Greeks.
(B) By the blind.
(C) In coded, secret messages.

(10) Celsius:
Temperature measuring scale, named after—
(A) Swedish astronomer.
(B) Roman scientist.
(C) British chemist.

BRAIN TEASER

Special triplet

IF three persons are inter-related or if they are totally unrelated, they will be said to form a special triplet In a set of any six persons, can you show that there is atleast one special triplet?

Here is a hint to make things easy for you Represent the six persons by six points. If any two persons are related, join the corresponding points by a black line, otherwise, by a red line. Thus, join all the six points in pairs by 15 lines some of them coloured black and some red. We have now only to show that there are always three points among the six whose three joins are of the same colour.

(Solution next month)

A. R. Rao

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Solution to May teaser

Who keeps lovebirds?

The method of logical elimination gives us the result. Let us start with the Desais who live on the southern side and do not keep a bird (sentence 6). The Desais live across the Herdias (sentence 1) who live east of the Watals (sentence 7) who live directly across the Anejas.

2	4	6
1	3	5

Bendres Parakeet	Watals Lovebirds	Herdias Parrot
Pathaks Bluejay	Anejas Canary	Desais No birds

The Desais do not keep a bird and live on the southern side (sentence 6), so the lovebirds are kept by the Watals, the parrots by Herdias and the Bendres live in apartment 2 (sentence 3). Thus the Herdias live in apartment 6, the Desais in apartment 5, the Watals in apartment 4, the Anejas in apartment 3, and by elimination, the Pathaks live in apartment 1. The parakeet is kept by the Bendres (sentence 4), the bluejays by the Pathaks and by elimination the canary is kept by the Anejas (sentence 2) because the Desais do not keep a bird.

PRODUCT AS SUM OF SQUARES

IF ANY two numbers of the series 2, 13, 74, 185, 346, 557, 818... are multiplied together, the product can be expressed as a sum of squares in an interesting way. Thus, $2\times13=5^2+1^2$; $2\times74=12^2+2^2$; $2\times185=19^2+3^2$; $2\times346=26^2+4^2$; $2\times557=33^2+5^2$; $2\times818=40^2+6^2$; and 5, 12, 19, 26, 33, 40... form an arithmetical progression (AP) with a common difference of 7.

Again,
$13\times74=31^2+1^2$; $13\times185=49^2+2^2$;
$13\times346=67^2+3^2$;
$13\times557=85^2+4^2$; $13\times818=103^2+5^2$;
$13\times129=121^2+6^2$;
$74\times185=117^2+1^2$; $74\times346=160^2+2^2$,
$74\times557=263^2+3^2$; $74\times818=246^2+4^2$ and so on, where 31, 49, 67, 85 . and 117, 160, 203, 246 .. also form AP.

As a matter of fact, the numbers of this series can be obtained by varying the values of h in
$M_h=(4h-1)^2+(3h-1)^2=25h^2-14h+2$

For h=0, 1, 2, 3, 4, 5, 6, 7, 8, we have, M_h=(−1, −1); (3, 2); (7, 5); (11, 8); (15, 11); (19, 14); (23, 17); (27, 20), (31, 23) and so on,
=2, 13, 74, 185, 346, 557, 818, 1129, 1490 and so on, where we have, for the sake of convenience, used (a,b) as an abbreviation for (a^2+b^2)

An associated form is $N_h=(4h+1)^2+(3h+1)^2=25h^2+14h+2$ For h=0, 1, 2, 3, 4, 5, we have N_h=(1, 1); (5, 4); (9, 7), (13, 10), (17, 13); (21, 16); and so on; =2; 41, 130, 269; 458; 697; and so on.

The products of any two numbers or the product of M and N can also be exhibited as sums of two squares where one set of members form an AP. Thus.
$41\times130=73^2+1^2$, $41\times269=105^2+2^2$;
$41\times458=137^2+3^2$; $41\times697=159^2+4^2$; and so on.
$13\times2=5^2+1^2$; $13\times41=23^2+2^2$;
$13\times130=41^2+3^2$; $13\times269=59^2+4^2$; and so on.

A theorem, originally attributed to Brahmagupta, states that:
$(a^2+b^2)\ (c^2+d^2)=(ac+bd)^2+(ad-bc)^2=(ac-bd)^2+(ad+bc)^2$.
If we set a=4h−1, b=3h−1, c=4k−1, d=3k−1, the use of this theorem gives (after some simplification)
$M_hM_k=(25hk-7h-7k+2)^2+(h-k)^2$
$=(7hk-h-k)^2+(24hk-7h-7k+2)^2$.
Therefore, we have,
$13\times74=11^2+29^2$; $13\times185=17^2+46^2$;
$13\times346=23^2+63^2$;
$13\times557=29^2+80^2$; $13\times818=35^2+97^2$;
$13\times1129=41^2+114^2$
Here, 11, 17, 23, 29, 35, 41; ... form an AP while 29, 46, 63, 80,, 97, 114 ... form another AP.

R. Kothandaraman

Mr Kothandaraman is a retired Commissioner of Income Tax from Hyderabad.

How to get palindromes

PALINDROMES can not only be obtained from 1089 and its derivatives (SCIENCE TODAY, July 1982, p. 57) but also from a number of upside down numbers.

An upside down digit is one which when written upside down gives the same digit or some other digit among the nine digits we know. Thus 6, 8 and 9, are upside down digits in addition to 1 and 0. Digit 3 also may be included as its upper and lower parts are same. Making use of the above digits we can form many upside down numbers. But to produce palindromes, an upside down number should confirm to the following:

Either last or the first digit should be an upside down digit excluding 1 and 0, all other digits being the upside down digits. Secondly there should at least be as many ones or zeros, as the number of upside down digits in the number. Lastly, 3, 9 and 3, 6 should not be the first and last or last and first digits of the number respectively.

Thus 110339 is one upside down number formed satisfying all the above conditions. We can produce the palindromes from it as below:

(i) 110339 + 110336 = 220675
220675 + 576022 = 796697—a palindrome
and (ii) 16 + 19 = 35
35 + 53 = 88 – a palindrome

Thus all the numbers 11163, 1099, 1039, 106, 108, 16 etc. are upside down numbers from which palindromes can be produced while 169, 190, 3016, 18889 etc. are not.

D. Venkateswara Rao

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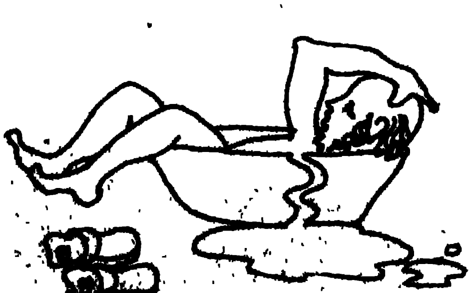
Law-abiding caterpillars

A BODY suffers a loss in weight when immersed in a fluid, and this loss is equal to the weight of the fluid displaced.

(Principle of buoyancy of Archimedes)



A truncated 'caterpillar' at power 3 level also suffers a loss in weight when its tail is restored to it, and this loss is equal to the weight of the disconnected appendage.

$$\frac{11^3+10^3+9^3+8^3+7^3+6^3+5^3+4^3+3^3+2^3+1^3}{11+10+9+8+7+6+5+4+3+2+1}=66$$

$$\frac{11^3+10^3+9^3}{11+10+9}=102$$

$$\frac{8^3+7^3+6^3+5^3+4^3+3^3+2^3+1^3}{8+7+6+5+4+3+2+1}=36$$

102−36=66

A. R. Kanga

AH! THE RAINS ARE HERE!

Can potholes be far behind?

Vishwas B. Dhekney

As we rush as we rush
in the rain
The trees and the houses go bumping back..
But the starry skies above that plain
come flying in our (holey) track...

Sunday at Sion
With apologies to James Thompson

POTHOLES are as old as roads and wheeled transport Soon after the invention of the wheeled vehicle came the bumps and splutters, the price of high speed even if it was only ten or fifteen miles per hour! Man's endeavour to make travel more comfortable was two-pronged—better wheels and shock-absorbers for the wheels, and, better roads, roads without ruts and potholes

The Romans were great road-builders But surely their roads were far more bumpy than one might imagine. And no less a person than the poet Horace complained bitterly about that marvel of ancient times The Grand Appian Highway! The first efforts at making good, stable roads were initiated by Mr John Louden McAdam, born in 1756 in Britain He is immortalised by the term "Macadamed roads" He proved that when evenly broken stones, called metal in engineering parlance, are smoothly laid and rolled they become locked in a firm mass without the help of clay He built roads without clay or earth But even *his* roads could not shrug off potholes Why?

Before we tackle the problem of potholes, let us first consider an imaginary, perfect road What are its characteristics? First, of course, it must have a good, firm base to handle the traffic Vehicles, whether stationary or in motion, exert pressure on the road surface. These pressures are borne down by the body of the road down to the natural layer of earth which can safely carry the pressures without being permanently deformed. This layer must be flexible it *is* compressed by pressure but must spring back to its original state when the pressures

Throughout the history of roads and wheeled vehicles potholes have been juggling spines big and small, famous and infamous. If we can't eliminate them entirely, can we at least control these pesky "mini-craters" which are the bane of the car-owner's life?

are off. Indeed if the base be so good why have a road at all, why not ride directly on the earthern base? Now this cannot always be, because these natural layers of earth are not able to take the pressures that the wheels cause. We need to water down the pressures a little, or in engineering jargon "disperse" the forces down through the body of the road to an acceptable level at the base. The pressure-resisting quality of the earth layer is assessed by the California Bearing Ratio method.* As you must have rightly surmised, it follows that what we have been calling the "body" of the road *(see diagram)* has to be stronger than the base earth layer, the upper layers stronger than the lower ones. Just above the natural layer we often have a 100 mm granular soil coat. After sprinkling a pre-determined amount of water, this surface coat is compacted by roadrollers, or even by hand, to a thickness of 75 mm. Field tests are then carried out to determine if the degree of compaction required has been achieved. A common field test is to find whether a certain percentage (usually 90 to 95 per cent) of "Standard Proctor Density"** has been achieved. Then, depending on the type of traffic expected and the quality of the base layer, more such compacted earth layers may be specified. These may be followed by W. B. M. layers, that is, water-bound-Macadam layers. These layers are made of hand-broken "metal" stones (55 mm to 90 mm in diameter) all broken from hard rock. These layers are "bound" by non-plastic stone or brickbat powder with

**C.B.R. express an index of the shearing strength of soil. The resistance of the soil to penetration, expressed as a percentage of the resistance for standard crushed stone, is the C.B.R. Thus, a C.B.R. of 50 means that the load in psi necessary to the penetrate a piston into the soil sample to a specified distance is one-half the load needed to drive the same piston up to the same distance in crushed stone.*

***Standard proctor density: every soil has a maximum dry density at an optimunm moisture content.*

light moisture content. They, too, are laid in 100 mm layers and compacted down to 75 mm. In the finalised road surface they usually form a total thickness of around 300 mm. The surface coat usually consists of hot-mixed asphalt Macadam with 45 per cent bitumen of 30/40 penetration. The bitumen as laid now, is of 75 mm thickness. This layer is topped of with a chip-coat of asphaltic concrete having 6 per cent bitumen content laid to a thickness of about 60 mm or more depending upon traffic conditions and rolled to a smooth finish. We have so far been discussing an "ideal" example. Actual conditions vary from place to place. The ideal road would also have to have the right type of traffic, that is; no over-loaded vehicles, ideal tyre pressures and braking pressures, and, adequate drainage of water at the base layer. The top layer should also be sloped to drain off the water through unclogged storm water drains. Wherever an area is expected to be waterlogged, at intervals toe walls should be provided to prevent the road constructional material from being washed away. Fibre-reinforced fabric may also be used to drain off the water and to prevent the mixing of the layers. Where the road rises above the surrounding natural terrain, the sub-base will have to be built after the right compaction and after providing the proper retaining walls on the sides to stabilise the earth. This, in short, is an ideally-designed, ideally-built, ideally-used, and ideally-maintained road. Can even such a road develop potholes too? All conditions being ideal, one expects no potholes. The road would have to be resurfaced; that is, in the case of asphalt roads, the top wear coat would have to be replaced/repaired every four to five years. And in the case of cement concrete roads, the joints in the concrete pavement would have to be filled in every ten or twelve years. Cement concrete roads would wear very slowly indeed and resurfacing would be required perhaps not earlier than 25 years. However, the impermeable quality, of not permitting water into the "body" of the road, would in this ideal road remain constant or would deteriorate uniformly between resurfacing periods. The road might "settle", but it would be again uniform and would make the road stronger rather than weaker. In the process the road material would interlock more closely. This would make it stronger with the passage of time. However, this expectation is belied whenever heavy loading occurs. For instance, four million repetitions of standard axle load of 8165 kg are enough to uproot the entire structure of roads built on the concept of the California Bearing Ratio. Why does this happen? In concrete pavements, a phenomenon called "pumping" is responsible. It refers to squirting up of water under the pavement at joints, which eventually can destroy the pavement. This however occurs only on roads with a base and sub-base of high clay-silt content. By providing granular material like sand and gravel, pumping can be prevented. Such ideal roads do exist. The trans-continental system of Inter-State Highways in the USA comes very close to being ideal. The roads pass through terrain varying from desert sands to marshy swamps, from areas with temperatures as high as 120°F to those under sub-zero temperatures and constantly under snow. This is not to say that they never experience failures but they represent points where their idealisations have failed. Deserts, areas with quicksand conditions, muskeg, swamps, freeze-thaw cycles, etc, present formidable challenges and research is still being conducted to overcome them. In such cases what constitutes an ideal road is also being researched.

It follows that whenever one deviates from the ideal conditions, one has failure of the load. The most common cause is lack of adequate road drainage, that is, removal of water from the road surface as well as from the sub-grade. Clay or silt content in the base and sub-base leads to volume changes. Clay expands with water. It cracks up and shrivels with loss of moisture. This moves the metal from

A concrete road in Amsterdam. While these roads do last longer, you cannot dig them at will, as asphalt roads are dug in India. Shown above is a section of an ideal road

the aggregate and can form a sort of tunnel through which the binding material can be washed away The external manifestation of this internal problem is a pothole The same sort of action takes place in areas which have freeze-thaw cycles, where entrapped water freezes and forms ice which occupies a greater volume than when it is in the liquid state This pushes the particles of the aggregate apart, or can even pulverize the aggregate On thawing ice turns to water and is drained off, leaving a cavity behind The cavity is filled loosely by the adjacent aggregate caving in from above The cavity thus progressively creeps upward to the road surface where it becomes a pothole How then do you drain the sub-soil? By using good granular filter material in the sub-base with longitu dinal side ditches with gravel and brick dinal side ditches with gravel and brick ballast, by providing porous towards the side, rain water can be drained away If water does not remain upon the road surface 12 hours after a good hard spell of rain, one may conclude that it has a good surface drainage The side ditches must also not have any stagnant water left

Sometimes stones used in the chip-coat (or under it with bitumen or tar acting as binder) have greater affinity for water than for the binder. Consequently, the binder is displaced by water, resulting in poor bonding and eventual deterioration of the road. When a road is well drained, the effect of moisture in the sub-base or base or sub-grade does not affect its load carrying capacity

Nevertheless, roads have often to be built in areas that are water-logged In such cases it might be necessary to build cut-off diaphrams within which the dry road could be built with a system of pipe drains. Alternatively, soil stabilisation or, stone piles or a bridge type structure might have to be used to suit the conditions This calls for surveys by experienced engineers A wrong decision often results in unending repair work

Another reason why potholes are formed is insufficient or incorrect compaction of the various base or sub-grade courses. Loose compaction leads to rearrangement of the aggregate metal when loads are applied. Even without any loads, this realignment can take place. This causes lacunae or cavities which eventually lead to the collapse of the surface, causing a pothole. However, not all soils need to be compacted. Some soils are naturally "strong" and further compaction may even lead to a loss of strength due to destruction of the internal soil structure. One instance of this occurs in places where the road is cut inside clay. Compaction also needs to be uniform and in accordance with anticipated traffic loads. On multilane highways the outer lanes naturally experience heavier traffic while the inner lanes are only used by faster-moving lighter traffic. These factors need to be taken into account while road-building. Else differential settlement between the lanes begins. It starts along short stretches first at places where overtaking vehicles undergo a bump, causing dynamic impact. It has been proved that impact of the axle load from a height of 75 mm increases the distress on the road by more than 50 per cent. This sort of impact is also caused when a trench is cut across a road and then refilled. When the filling is overcompacted and made stronger than the road on either side, it does not settle along with the road but stays up. Thus it causes impact forces. If on the other hand, the trench is not as well compacted, it "sinks" and again causes impact forces. Such a situation can only worsen and it is one of the commonest reasons for the formation of "trench ditches" across the road. Often when a trench is cut, it loosens the body of the road on either side. Subsequent filling of the trench, even if it is done correctly, might not be sufficient since the loosened sides will cause settlement adjacent to the trench All over our country after a road has been resurfaced, traffic is often allowed to pass over it *before* the bitumen or tar asphalt has had time to set This causes removal of the blindage as well as binder and destroys the impermeable waterproof quality of the surface. Water can then seep into the road "body" and cause the damage described earlier. Excessive binder, whether tar or bitumen, or in-

Rural roads, far from the madding crowd, ought to be relatively stress-free. They are not. Some are subjected to the worst loading imaginable

sufficiently heated bitumen (at the time of application) and poorly spread binder cause the blindage to float. This leads to the binder being squeezed out.

The binder has to perform the important function of holding together the interlocked aggregate. If the aggregate is wet or has dust on it, it does not adhere to the binder. Also, the wrong kind of binder results in loss of adhesion. The binder is selected on the basis of the expected traffic. The qualities to look for in a binder are its adhesion to aggregate and resistance to water. One must also consider the temperature at which it is to be applied, how hard it becomes upon setting, how temperature affects it, how viscous it is, what is its "penetration", whether upon reduction of viscosity it becomes brittle and cracks up, etc. A wide range of tar and bitumens are available for every type of use. The designer has to choose the right combination. When it rains just after the road is built, there is deterioration and potholes are certain to be formed in such locations, since the top coat becomes permeable to water. Overheating of the binder prior to application drives out volatile oils leading to brittleness. Braking of vehicles causes longitudinal forces on the pavement. This causes strains in the pavement. The part in front gets compressed while that at the back of the tyre is under longitudinal tension. Thus distress is to be expected at intersections of roads where braking and restarting are most common.

The roads in our rural areas are often just water-bound macadam roads without any surface treatment. These are subjected to some of the worst loading imaginable, namely, narrow steel-shod bullock-carts loaded with produce which causes pressures measured almost 500 times those caused by pneumatic tyres. Moreover, we also have tractors and trucks plying the same route. The extreme stresses due to the steel tyres causes the stones in the WBM to be pulverised systematically. The damage is accelerated by the fast-moving rubber tyres of trucks; these create a partial vacuum behind the wheel and literally suck the stone dust out of the road. Since the paths of the carts and trucks are fixed due to the narrowness of the roads a long "rut" in the road is a predictable consequence. The central portion of the road, which is seldom used, sticks up. This, combined with the action of the rains which wash out the loose binding dust, leads to a rapid deterioration of the roads. This phenomenon is especially noticeable in areas like in Kolhapur and Karad in Maharashtra where rapid agricultural development has taken place.

Overloading of roads also causes settlement and deterioration. Overloading can be of two types: one resulting from a literal overload on axles and the other resulting from speeding. When a vehicle moves it has a certain momentum (mass x velocity). Due to the property of inertia it tries to keep its velocity but due to traffic conditions the vehicle has to change direction and speed. Thus forces have to be applied to cause these changes. Ultimately these forces are passed on to the road. If the vehicles are moving at speeds greater than the design speeds, overloading is inevitable.

That in essence in the life-history of a pothole. As examined earlier, its geneology is complex—remember many factors and many agencies lend a hand in the genesis of a pothole, which rattles your spine and wrench your muscles: □

Mr. Dhekney is a consulting structural engineer. He has a B Tech from I I T Bombay and M.S. from Oklahoma State University

Price of folly

Vishwas B. Dhekney talks to Mr. J. R. Patwardhan, Director, Special Engineering and Project, Bombay Municipal Corporation. On the pitfalls and potholes of our city roads

How do you refill the trenches that are dug in the road? What method of compaction do you use?

The material that comes out of the trench itself is used to fill it up. To compact a deep trench, one should flood it with water and follow it up by using mechanical aids like plate vibrators, earth masters or by regular powered rollers if the width of the trench is sufficient. This should be used to compact the top 1.2 metres. This operation is sometimes neglected during re filling of the trenches and it gives rise to uneven settlement and subsequent problems.

The degree of compaction is tested by the field density test and it is normally necessary to achieve 95 per cent of the laboratory density. To drain sub-soil water, drains are provided. These are loose jointed unburnt stoneware pipes, covered by granular metal, running along and across the roads below the subgrade and ultimately connected to suitable discharging points. When you don't provide such drains, naturally problems are bound to plague your roads.

What measures are taken to stabilise roads on reclaimed land?

The filling on reclaimed land is done layer by layer and compacted with optimum moisture content. But many a time the required standards of the method are not observed. If the virgin soil is blue marine clay the initial consolidation is achieved by providing sand drains. Compaction also is achieved by providing sand layers at every one metre depth. In the case of roads built on such reclaimed soils, the final wearing coat is provided after two to three years. However, for the past 12

Water is the prime enemy of asphalt. Thus a road already under stress rapidly develops potholes in monsoon

years it has been found that the wearing coat of some roads like the Eastern Express Highway is required to be renewed every year because of the uneven settlement.

How do concrete pavements compare in cost to asphalt?

With the existing price structure, a concrete road of the specifications mentioned earlier, costs approximately Rs. 200 per square metre while an asphalt road costs Rs. 160 per square metre. A cement concrete road lasts for more than 20 to 25 years, while a asphaltic road has a life of 10 to 15 years. Moreover, even during this period the asphalt road needs rejuvenation in the form of a chip coat every five years whereas the cement concrete one needs only refilling of the joints and dressing every 10 years.

Asphalt melts in summer and is worn out or forms lumps. Then the rains follow. Does this chain of events cause problems? If so, how does it contribute to the formation of potholes?

Asphalt does soften in summer and shows signs of distress under traffic. Water being the prime enemy of asphalt, the monsoon causes further damage to the already distressed road leading to the formation of potholes. However, a well-designed and properly constructed asphaltic road should be able to withstand the monsoon fairly well since it is designed for all sorts of adverse conditions. The drainage arrangement provided during the original construction can be disturbed because of the repeated excavation of the trenches by various utilities and improper back-filling due to restricted working hours, because of heavy traffic. Leakage through the ancient water mains which have been laid more than 60 to 80 years ago is another reason for failure. Renovation of these old water mains and of the service connections from them often requires excavation of the roads—and the vicious circle continues. Attempts will, therefore, be made in future to strengthen the existing old water mains wherever possible with mortar by using techniques which are not yet available in the

Duckfeet are allright for village roads but not steel-shod carts.

country.

Why are most potholes formed during the rainy season?

Since water is the prime enemy of asphalt, it is but natural that most of the potholes are formed in the rainy season. In some areas of Bombay, which lie below the high tide level, water accumulates both during the periods of high tide and heavy rain. Thus, moisture soaks into the roads to a considerable extent leading to the formation of potholes. Coupled with the lack of sub-surface drainage, these potholes keep on rapidly increasing ultimately ruining almost the entire road surface. Moreover, these roads are always subjected to heavy vehicular traffic even when badly damaged.

How does heavy vehicular traffic affect the roads?

Heavy vehicular traffic affects the pavement of the roads in three ways:

(i) Repetition of axle loads: four million repetitions of standard axle loads of 8,165 kg. have been proved to be sufficient to uproot the entire structure of the road built on the concept of the California Bearing Ratio.

(ii) It has also been proved that the impact of the axle load even from a height of even three per cent to six per cent enhances the distress in the road by more than 50 per cent.

(iii) Unofficial overloading of vehicles is also responsible for severe damage to the road surface. It has been estimated that even 10 per cent of excess over the designed load causes 50 per cent more distress than the normal one.

Is the problem of bad roads, due to lack of finance or lack of work ethics or lack of coordination?

The appalling condition of the roads in Bombay can be attributed to frequent excavations without coordination between various utilities; for instance, last year alone, Bombay telephones laid 1,600 km. length of cables, while the total length of the roads in Greater Bombay is 1,430 km!

We also have a system of recommending the lowest tenders irrespective of the suitability or the reputation of the contractors and the implements possessed by them, the quality of the road surface thus gets affected. The contractors are registered category-wise and even the best contractors have to work under worsening conditions. Also, their working at odd hours is not welcomed by the public.

Lack of finance is one of the reasons for the sorry state of Bombay roads. To maintain the roads 26-30 crores of rupees will have to be spent every year for the next 15 years. And with inflation the prices will keep escalating. The present budget provides not more than Rs. 15 crores for strengthening, rebuilding, resurfacing and routine repair of roads.

The average vehicle in Bombay runs four million km. every day. The cost of running an average vehicle per km. per day is approximately two rupees. This gives us a figure of Rs. 250 crores per annum for running of vehicles on Bombay roads. If people, who run these vehicles can afford to spend Rs. 250 crores on running their vehicles, there is no reason why they should not spend 10 per cent of this cost for the maintenance of the roads which ultimately will mean a substantial saving in the repair cost of their own vehicles. □

CONCRETE WORSE

Vithal C. Nadkarni

Why are new concrete buildings, meant to last for 100 years, crumbling down within 5 to 10 years? Don't our civil engineers have any stake in the buildings they design? Why do we allow unscrupulous contractors and self-styled developers to amass fortunes at the expense of the poor consumer who has no option but to cough up extortionate amounts? Whose responsibility is it to ensure at least the minimum standards in the construction industry?

THE last sound watchman Singh* ever heard was that of collapsing columns and crumbling concrete. But he probably didn't know what it was. He was sleeping in the godowns of Akashdeep, the seven-storey building that collapsed like the proverbial pack of cards across the railway track at Grant Road, Bombay last August.

Watchman Singh died along with 13 others, buried beneath a mountain of debris that could not be cleared for days and eventually cost a whopping Rs. 14 lakhs to shift.

Close on the heels of the Akashdeep tragedy came the country's worst ever building diaster, the crash of the Gangaram Shopping Complex in the "space city" of India, Bangalore; 120 people were crushed beneath the beams and slabs of the nine-storey building that was still under construction.

Collapse of buildings is hardly a new phenomenon. In a city like Bombay hardly a monsoon passes without some old *manzil*, mansion or *mahal* suddenly sliding to the ground. (Seven buildings including Akashdeep tumbled down in a period of just two weeks!) Since 1970 1,300 buildings in Bombay have fallen, averaging 118 a year. The Bombay Municipal Corporation's survey in 1980-81 classified 1,752 buildings as beyond repair, 8,707 as unlikely to last more than five years and 19,778 as having a life of between 5 and 15 years.

But the point is Akashdeep was no old grandmother of a building. It had seen but nineteen summers (or monsoons), a building that ought to have been like a girl in the bloom of her prime, with at least a four score and ten years of life ahead.

It is when such buildings crumble to a grossly premature end that charges like "murder most foul" begin to fly. And with good reason. Modern high-rise buildings made by modern methods and with modern material, have no business to be down earlier than 100 years. And if they are, it is a tribute to the lack of skill or care on the part of their makers.

* *Actual name withheld.*

The untimely collapse of these concrete buildings has stirred a raging controversy: how good are our engineers and how scrupulous our contractors? How safe are the buildings made by them? Was Akashdeep the exceptional *bet noire*, a black beast in a flock of angelic whites, buildings that are mushrooming all over the country? The questioning has begun, although some say, belatedly...

Meanwhile, the story of "India's crumbling concrete" has made international headlines; Anne Charnock of the *New Scientist*, London, charges that India's engineers have entered the space age, but they no longer know how to make concrete!

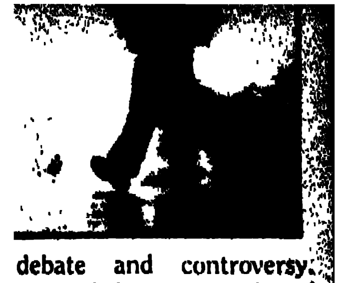
A soaring satellite and a sinking skyscraper make an odd couple indeed. How justified is such a juxtaposition in a country like India? Incidentally, in a recent issue, *India Today* carried an eulogy of our space programme on its cover with the picture of astronaut Rakesh Sharma. Inside was also featured a scathing expose on the "building blight" of the Delhi Development Authority: over 5,000 buildings worth Rs. 15 crores made in defiance of specifications. Nor were the prestigious Asiad-82 buildings free from the blight—they were likely to last for far fewer years than expected earlier.

The question that troubles is: if the Asiad buildings, made in such a blaze of publicity are suspect, what about all those concrete buildings that are coming up in the obscure corners of our suburbs and mofussil areas? Are they also all potential death-traps? It *is* a controversial issue, one that goes beyond the safety of just your home and hearth. For the question of faulty concrete touches also the foundations of the so-called "temples of modern India"—dams, bridges, canals and roads—symbols of a nation's development achieved at a great cost (the construction industry accounted for 42.5 per cent of our planned expenditure, according to one estimate).

The controversy begins right here: some experts like Tony Remedios, a construction consultant, in Bombay, who is also called Tony Ramdas, India's concrete "guru", say that much of the concrete produced in India is bad. (According to the now disbanded Concrete Association of India, in 1980 the country produced some 150 million tonnes of concrete; extrapolation for 1984 gives a figure of 240 million tonnes. At an average rate of Rs. 450 per tonne, it cost 54,000 million rupees.) Other experts like Dr. V.N. Gupchup, Principal of Victoria Jubilee Technical Institute (V.J.T.I.), at Bombay, believe that as much as 90 per cent of our concrete, the portion that goes into public works involving the Government and large agencies and contractors is all right. It is mainly the housing sector, involving particularly the cooperative societies, that is facing the problem of substandard concrete.

This reminds us of the joke about a pessimist and an optimist looking at a half empty and a half full glass! Statistically, an optimist might comfort himself by saying that 90 per cent of our concrete is satisfactory But the pes-

THAN CLAY



simist counters that the housing sector, although numerically inferior, is strategically more vital, and of greater human interest. This is not to suggest that experts like Dr. Gupchup condone the malpractices rampant in the construction industry. Nor would they wish to accord lower priority to private housing. Indeed, every one we met, and that includes builders, was quite vehement in denouncing the "failure of men and materials" wherever it might occur.

While no one we met would admit to practising faulty construction, we did encounter a healthy new attitude—to face up to collective responsibility. (Buck-passing was even discussed at a recent seminar which had the appropriate symbol of an accusing thumb with the slogan: NOT ME, HIM!)

Now to consider the reasons for the "failure of men and material". We are not talking about manifest excrescences like wilful adulteration or doctoring of designs. We shall go back to the basics first, namely, what makes good concrete?

Concrete is a building material of great antiquity. It is composed of cement, stone and sand (together known as aggregate) and water. "Each of these constituents has a specific function," writes M.Y. Sabnis, Executive Engineer with the Bombay Municipal Corporation, in his book *Cement Concrete Mix Design Principles and Practice:* "The cement with water forms a slurry which fills the voids between the sand (fine aggregate) particles to form mortar. And mortar fills the voids in the stones ("metal" or coarse aggregate) which mainly acts as a filler."

The introduction of admixtures, as a fifth ingredient to improve the character of concrete, is a relatively recent development. Compounds such as calcium chloride are called set-accelerators, while there are also set retarders, less often required (these are usually sugar based). The purpose of most admixtures is to increase the workability *without* having to increase the water content and without thereby affecting the eventual strength of the concrete. Such compounds are also called plasticisers. They are mostly derivatives of lignosulfonic or hydroxylated carboxylic acids. Some admixtures decrease the permeability of the set concrete and are thus called waterproofers. Entrainment of air also increase the workability of concrete.

However, a more widely used and equally controversial admixture is pulverised-fuel ash (fly ash). Since it has pozzolanic (cement-forming) properties, it is added to reduce some of the normal cement content. It reduces the heat generated during setting. This then is the principle behind the much-touted pozzolana cement (also called "Janata Cement") which was supposed to "boost" our cement production. Other factors being equal, fly ash can increase the eventual strength of the concrete: But many builders complain that in the name of pozzolana "any old rubbish is added to scrimp on precious cement in India". Some even charged that pozzolana was only another name of officially adulerated cement!

Concrete is easy to work; all you need is a mould or form and time at room temperature to let the concrete set. But, although concrete is remarkably resistant to compression, its tensile strength is poor. So, to enable a structure like a tall building to cope with tensile forces also, engineers came up with what they term a "marriage made in heaven"—concrete reinforced with steel which has excellent tensile strength. This places an added burden on the concrete-maker. He has to deliver a product that is both dense and impervious to prevent corrosion of the steel inside. One of the major causes of steel rusting is the lowly cover block This is used, at intervals of one metre, to maintain the reinforcing steel bars in the correct place. When these are badly made and porous, they become the Achilles heels of concrete.

The secret of concrete's strength lies in the chemical reaction between cement and water, a process known as hydration. Precisely how does it occur? That is itself a matter of intense scientific debate and controversy. There are two rival theories, one based on the role of crystals and accepted by most U.S. researchers and the other model, developed by English scientists at Oxford, emphasising osmotic forces

Whichever camp you belong to, whether osmotic or crystalline, you have to agree that the less empty the space between the aggregates and the cement, the stronger and more durable the concrete. "Cement is technically lovely," says James Hansen in *Science 82*. "The basic ingredients to make it are cheap and plentiful. And while the high-temperature kilns gobble energy—it represents nearly a quarter of the cost of finished cement—turning cement into concrete at the construction site uses little more." It is at the construction site that many of the sins of omission and commission against concrete occur.

"The civil engineer on the site must know the art of making controlled concrete and the techniques of mix design—choosing the economic proportions of cement, fine and coarse aggregate and any admixtures—so as to obtain a cohesive concrete of specified strength and the desired workability and durability from the available materials," writes Sabnis.

Thus, given good materials, "failure of men" occurs when there is no competent supervision and control on the process of concrete-making. "R.C.C. construction is a scientific process which is excellent in the hands of qualified and experienced people but dangerous if managed by incompentent engineers and contractors (or *mukadams* or *mistries*)," says Dr. Gupchup. And Tony Remedios agrees, vehemently. "Where are all the competent men gone?" he asks exasperatedly. According to him, "They have either risen up in the ranks to the tops of their pyramids, at desk jobs or have retired. Most have probably forgotten the practical lore they had learnt from their own seniors years ago. They (the big bosses) seldom come to the site. And when they do, they are always on a flying V.I.P. visit'. The supervision of

big construction projects is delegated to raw juniors who get no on-site training in their degree courses "

In effect, therefore, on-site mixing of concrete, a most vital operation, is left in the hands of 'experienced" construction gangs and their bosses *(mukadams)* Even builders concede that these can and do intimidate the green graduate supervisors Says N D Patel, Honorary General Secretary, Builders Association of India "Many *mistries* prefer watery concrete *(patla mal)* for ease of handling But they don't realise that extra water can result in weakening of the concrete (five per cent extra water can weaken some concrete mixs' strength by as much as 30 per cent!) Nor is it enough to only prepare concrete in the 'textbook manner', it has also to be placed and vibrated correctly in the formwork to eliminate air pockets and to make it cohesive Then it has to be diligently cured ' A supervisor trying to enforce discipline or trying to check errant *mistries* faces the risk of work stoppage or has hostile labour on his hands

Increased use of plasticisers is one of the solutions proposed to tackle the problem of producing workable con crete Some prefer to alter the mix design, varying the basic ingredients to get higher mobility while retaining the required strength Says Patel, 'The advantage of plasticisers is that they also effect a dramatic saving of cement—one to two bags per batch or 5 to 10 per cent of the total consumption We would like to see the import of additives like super-plasticisers which are tremendously accelerating the speed of construction in countries like America and Germany '

However the use of plasticisers does not make concrete mix design any simpler If anything, it calls for even greater care and monitoring the cost of which many builders are unwilling to bear. *(See box about dangers of additives)*

This brings us to a popular myth about concrete—that it is simple It is not It is unlike any of our traditional building materials—stone, wood or marble Yet lay workers habitually take all kinds of liberties with it But for concrete's innate resilience this should have caused disasters galore

"A high-rise building made today with latest techniques is as much a product of high technology as a racing car or a computer But the level of infrastructure is astonishingly primitive in the construction industry The bulk of the people involved in this high-tech enterprise are illiterate and untrained, ' says Mr N R Tembe, Professor of Civil Engineering at V J T I, also Head of the Technical Committee that investigated the Akashdeep collapse To keep costs down in this high tech enterprise, many builders do away with qualified supervision The attitude is why pay for an engineer, a mere employee who might veto your plans, stop your work and even order substandard work to be pulled down? That means wasting time, doing tests, checking sample concrete cubes, checking your sand, metal and cement and attention to a hundred details which is what quality control is all about

"Look for a moment at our material concrete—in an objective fashion,' says Professor Tony Cusens President of The Concrete Society, U K "It is difficult enough to ensure that we put in the right constituents to the correct proportions, and to place it in the right way in the right moulds But think what happens when it has set and hardened It expands with the heat, contracts with the cold, takes in mois ture and expands exudes moisture and shrinks, it contracts when compressed and goes on doing so for years It is a living, breathing and moving material and this simple philosophy tends to be ignored by designers distracted by the other complications of major structures Such a complex material needs a hi-tech approach and not low technology thinking The fact that every amateur gardener or DIY enthusiast can put together some sort of concrete should not distract us from the recognition that the achievement of a high quality concrete needs as equal refinement of approach and skilled workmanship to that demanded by high technology."

ADDLED ADDITIVES

A TEAM of scientists led by Mr Don Beresford of the Commonwealth Scientific and International Research Organisations, Division of Building Research in Australia has investigated some of the more likely reasons that concrete today is decaying earlier than it used to. We know that many concrete structures over 100 years old are still performing without problems, yet much new concrete is decaying

Mr Ian Rust of Henderson and Horning, Australian Realtors, is reported to have explained one notorious concrete failure as "Water penetrating the skin (laminate) and getting into the reinforcing steel, which had begun to corrode and expand. This had led to some cracks." At any rate it would be difficult to deny that corrosion of the steel is the reason for nearly all of the failures in pre-stressed concrete

The strength of modern concrete is on the average double that of concrete poured at the turn of the century Consequently builders now use lower amounts of Portland cement To cut costs, slag ashes from blast furnaces and fly ashes from coal-fired power stations (pozzolana) are used as fillers There is a real possibility that these cheap fillers contain highly corrosive materials that start or accelerate rusting of the steel

It has been the practice of architects in the U S to specify that structural steel (such as I Beams, H Beams and Angle Bars) be painted before being embedded in concrete Outside U.S.A the steel generally is not painted It is just assumed that they will be allright without corrosion protection This was true in the "good olde dayes" when they didn't stretch the concrete with corrosive extenders or add admixtures that hurried up the curing, or increased the strength We now suspect that some of these additives are highly corrosive (Calcium chloride, a set-accelerator, used earlier is now actually banned) Thus the "rules of the game have changed" What performed well in the past does not necessarily perform well in today's different conditions

What is the solution? There probably are many The additives could be omitted, a higher amount of Portland cement could be used and various other approaches could solve this problem Another method is to make the steel corrosion resistant

Our builders, contractors and consultant engineers have obviously not heard of President Truman who said: "The buck stops here!"

To say all this is not to start another myth—that good concrete is necessarily expensive. It is not. "In fact, good controlled concrete is far cheaper in the long run," says Mr. R. N. Raikar, Managing Director of Structwel Designers & Consultants. "Think of the hassles, the endless repairs, the waterproofing, the repainting and guniting. All this can be nipped in the bud."

That presupposes the existence of two things: the *knowledge* of how to make good concrete and two, the *will* to make it. If a contractor lacks the will (and often the ability, too) to make good concrete, is it not the duty of the consultant or architect to ensure that he *does* produce the required standards? But a more fundamental question is why should incapable and unwilling persons be allowed to enter this vital (and lucrative) field?

Surprisingly, financial solvency is the only criterion on which builders are judged in our country. Our civil engineers do not need a licence to practice. Nor do we licence our builders. Both are therefore free to get away with holy murder as happened in the Mumbra building collapses which probably involved violation of every principle in the book.

Given the acute shortage of housing, most consumers are in no position to protest. Ironically, a badly made flat is as expensive as a well-made one. "It's not like buying rotten *baingan,*" says one disillusioned flat-owner who has spent a fortune on keeping together his disintegrating flat. "You can't escape paying through your nose!" Says Vijay Gad, ex-Chief Engineer, (Civil), Department of Atomic Energy, now, President, Pheroze Kudianwalla Associates: "When people make so many compromises how can they expect quality?" In other words, people get the kind of buildings they deserve. But when they are paying such extortionate amounts, the least they can expect is a roof that does not leak, walls that are safe enough to drive a nail into *without* starting an avalanche. (This is not a joke. We saw a society notice in a 30-storey skyscraper at Cuffe Parade, Bombay, that warned tenants not to hammer their shear walls. The notice openly admitted that because of the "new design" involved in the construction of the buildings, such activities could cause it to collapse. And the building is hardly eight years old!) Experts like Gad agree: "Corruption, unfortunately, is ubiquitous—it is as rampant in Japan and The U.S.A as in India. But in those countries they have quality-*plus*-corruption. Here we have only corruption! I feel quality control is like a two-sided equation: on one hand is the owner-consumer; on the other, is the contractor-builder. If the contractor falls short, or his will to make a good building flags, the other side should make an extra effort to keep the balance on even keel."

The moot question is: Should the consumer make that effort? After all, you don't appoint a quality control inspector everytime you buy a life-saving drug nor do you consult an automobile engineer to check out on your car when you buy one. In all other purchases is enshrined this concept of *minimum* quality assurance. Why not in housing? Whose responsibility is it anyway?

Moreover, you may not be in a position to influence the construction of your flat when you buy it ready-made. And what happens with a large condomium with two hundred tenements? Do all 200 tenants appoint 200 odd consultants or supervisors? Furthermore, laymen are unable to distinguish bad concrete from good. The problem is compounded by what one consultant calls "beauty skin-deep"—defects of the concrete and the "sins" of its makers can easily be concealed behind a layer of plaster, paint or marble.

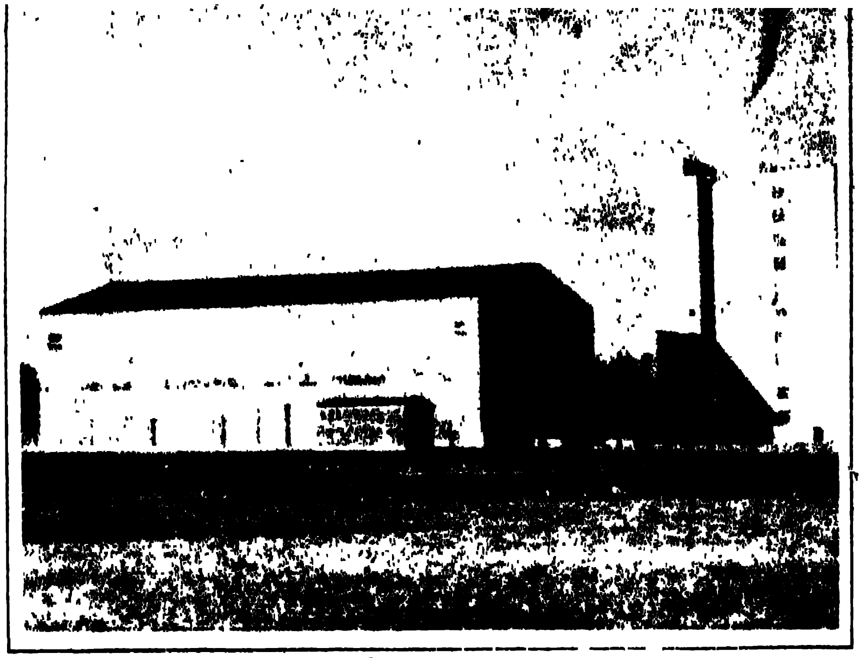
Also, one of the dictums is that, unlike a wife, a building only begins to reveal its true colours after a long interval, say, five years after completion. Says Tembe, "That is if the building is still standing. That means the construction has weathered the sins of its makers. Now it is up to the user or tenant. If he looks after it, even a bad building can be made to last. But he must rectify the defects that are revealed." (According to Remedios, a badly made building is like a weak baby. It can be kept alive provided you swaddle it: protect the concrete, paint it frequently or change the plaster, generally keeping out the ingress of atmosphere.)

That raises another basic question: what is bad concrete? Obviously, concrete that is porous; concrete which fails to come up to specified strengths and grades. Because the voids in such concrete are unplugged, it has a honeycomb-like appearance (In contrast to the form-finished concrete which has a smooth hard impervious surface). And because it is vulnerable to attack by moisture, the steel used to reinforce honeycombed concrete begins to corrode. This eventually disintegrates the concrete because steel expands three to four times its original volume on rusting. This process is also called spalling. The expanding interior, causes pieces to break away from the surface.

We have so far discussed "failure of men". What about engineers who have both the knowledge and the will to make good concrete? Do they get the material they want? Most emphatically not! The abysmally variable supply of sand, cement and steel in India can be seen on any site that one might choose at random.

The scandalous state of affairs in the cement sector is also well-known. That could probably become the subject of a separate controversy. The present controversy centres around a colossal botch-up of a fine technology and the consequent wastage of precious resources. As a leading cement technologist in U.K once remarked, "Unless somebody takes the trouble to knock it down, a properly made cement building ought to be standing in a thousand years."

Here, with no trouble at all, they are knocking them down in five to ten years! Who is to stop them? □



FIRE! FIRE!

Bill Atkinson

LANARK County Concession Road 8 passes by an unusual farm five kilometres west of Almonte, Ontario. Like neighbouring properties, it has hay, beef, alfalfa, a barn and a silo. This barn, however, is unlike all others, for it cost three million dollars and contains some of the most sophisticated instrumentation in the world. The 'silo' is even more bizarre it is in fact a ten-storey concrete high-rise tower, connected to a single-storey service building. This is no ordinary farm It is the Fire Research Field Station, completed in the autumn of 1981 and part of NRC's Division of Building Research.

The Almonte facility is one of only a handful in the world: others are in Britain. France, the U.S., and Japan. Why Canada as well? "Because our fire record is one of the worst in the developed world," says Dr Alan M. Phillips, Manager of the Field Station. "In 1981 we had 79,000 reported fires whose direct damage was almost a billion dollars and whose time and dislocation loss was four times that. Canadians stand one chance in a hundred of suffering fire injury in their lifetimes. That's a greater risk than traffic accident."

Phillips explains that the barn is the "burn hall", while the high-rise structure beside it is the "fire tower". In the cavernous burn hall, NRC scientists examine the behaviour of fires *per se*, while the fire tower is for investigations of fire propagation and the movement of smoke in tall buildings.

Although each of its ten stories has a test-floor space of only 36 square metres, the fire tower can simulate patterns of air and smoke movement in a full-sized building. The tower's outside cladding can be removed and other building facades substituted, or tests run on special ledges intended to stop fires hopping up an outside wall from one floor to the next.

The unheated burn hall shelters full-sized, all-weather fire experiments, and can accommodate mockups of apartment and hospital suites, two-storey dwellings, and even shopping malls. Researchers can also open the hall to the tower at ground level, studying complex urban assemblies.

Why is all this necessary? "Because some current building practice may rest on untested assumptions," Phillips says. "Sometimes, for instance, smoke detectors have given warning only when occupants are already unconscious or trapped. We don't yet fully understand how smoke behaves in buildings. That's one reason why we built this place."

The Almonte Fire Research Field Station, NRC's Division of Building Research

At first, "this place" appears as calm as any other research establishment, its excitement purely intellectual. Gradually, however, one becomes aware of the *visual* excitement of the Field Research Station, a view shared by its personnel. "I'll always remember my first fire," Phillips says. "It wasn't like the usual laboratory experiment where all you can do is watch needles bob. You see results quickly, dramatically."

We walk to a small room of concrete block, built in one of the Burn Hall's corners. This is a test chamber, in which fire research scientists construct wood cribs of standard size and material, set up their instruments, and touch off blazes whose peak power output may rise as high as three megawatts. Today the little fire-blackened room is empty, a series of test burns having been completed the week before.

"When NRC began in this business," says Phillips, "all that told one what was going on during a burn were strip charts. A pen at the end of a metal arm noted some variable, pressure or whatever, on a strip of paper, in effect plotting it vs. time. Then when the experiment was over, one unwound the paper chart and read off the data. The instrumentation's infinitely better now."

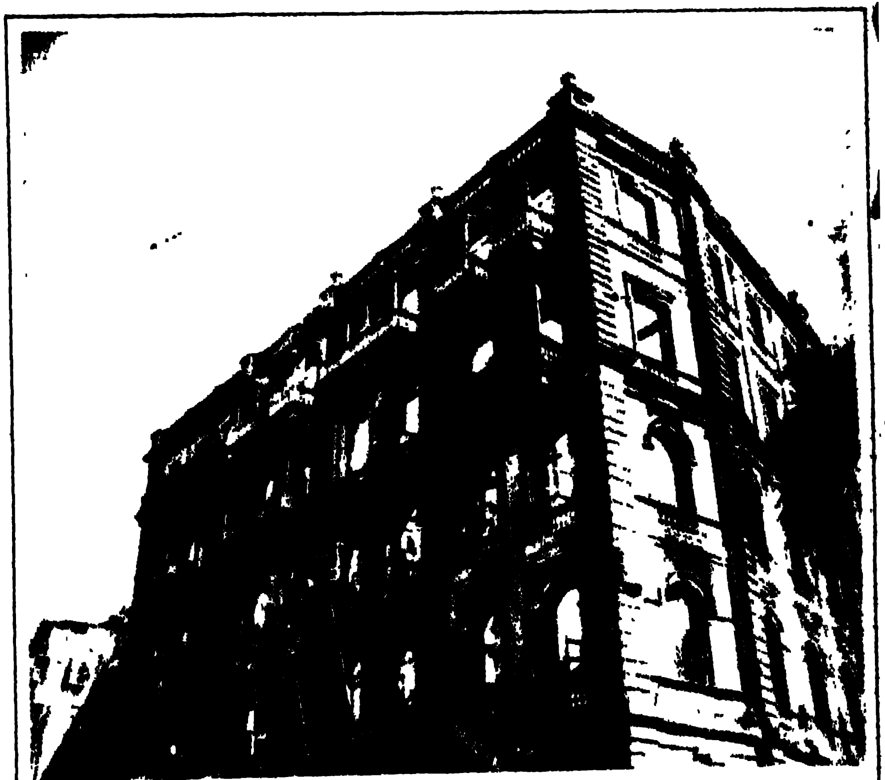
The best characteristics of the old strip charts have been built into computerized readouts, whose monitor screens present data in full colour and real time. Seated at the console of a computer in a control shack near the burn room, Phillips and a technician command their digital genie to summon up earlier results, superimpose them on new ones, and blend the two to derive trends and patterns. It is a fascinating display. This new approach digitizes data as physically close as possible to the actual experiment, converting the sensor's analogue outputs into the on-off bits of machine talk; computers near and far can thus massage the information as soon as it is produced.

"Digitising makes for a cleaner signal." Phillips says, pointing at an overhead cableway that whisks the newborn data off for processing. "We transmit now with much less signal loss."

The Almonte computers read up to 200 sensor channels simultaneously during a burn. But what do all these sensors sense? "Pressure and temperature at every key position Velocities of air moving in to feed the flames, and of combustion products rushing out. There's a smoke-density sensor which works by the same principle as some home smoke detectors—our people are in the final stages of turning a laser version of this into a workable device. Then there are the gas analysers." These give fire gases a "breathalyser", both in real time (as a fire progresses) and, taken away in bottled form, for ultra-high-fidelity breakdowns in another lab.

What happens if a test burn gets out of hand? This is most unlikely for these controlled experimental fires; but because the Almonte facility is far from any municipal fire department, it has a full array of its own firefighting devices. Among these are hoses supplied with water from a reservoir beneath the burn hall ("We recycle it so it's not dumped into the local ecosystem") and, in the corners of the hall, "four jolly big fans" that together can exhaust 3500 m³/min of smoky air to the outside. The whole building is oriented NW-SE so the prevailing wind can assist smoke clearance.

Near the small block room is a strange-looking apparatus that looks like a section of a standard roof. "This is our roof test apparatus," Phillips explains. "Many fires spread because 'brands', or bits of burning material, settle out of the air and touch off the roofs of other structures. We had just finished installing this apparatus when California, which buys most of British Columbia's cedar shingles, announced new limits for flammability of new roof materials. Canadian companies could have met these standards by shipping untreated products to the U.S. for a chemical soak, but instead they decided to develop their own new flame-retardancy techniques, thus keeping the treatment business at home. We can test here for the effectiveness of the new products."



The Facility's location, well away from the main NRC campus in Ottawa, was chosen because the smoke produced from certain types of burn experiment would not be tolerated within the city. Despite the relative isolation, it is still an integral part of the Division's Fire Research section according to Alan Phillips. The section has been studying the effects of fires on structures for the last thirty years, and the lessons it learns at the world-class Almonte facility should, in the long term, reduce the loss of Canadian lives and property to fire. □

Excerpted from Science Dimension

METHYLATION AND REGULATION OF GENES

THE MECHANISM by which fertilised eggs develop into multicellular organisms has been an enigma to biologists for almost a hundred years Surely, cleavage divisions by themselves do not lead to embryological development. Its real essence instead is the process of cell differentiation. At molecular level, it is known that soon after fertilisation, most of the genes are 'switched off' and during development different sets of these genes are 'switched on', on a selective basis, in different groups of cells. How this tissue-specific regulation of gene expression is achieved has been among the deepest of all the mysteries of a multicellular organism. At one time this was thought to be indecipherable but results in recent years are encouraging. Part of the answer may be in a simple chemical modification of DNA

This chemical modification is known as 'methylation' of DNA and involves the addition of chemical groups called methyl groups ($-CH_3$) to one of the sub-units, cytosine of the DNA molecule. It is known that active DNA is generally less methylated than the inactive one. Another peculiarity of methylated DNA is that once established in any given cell, the mould is inherited faithfully by all its progeny.

The marvel of 'mass switching off' of genes was discovered by Rudi Jaenisch and his colleagues at the University of Hamburg, in early embryos, a couple of years ago. They had injected viral DNA into early mouse embryo and the viral DNA was integrated with host DNA They were surprised when all the foreign DNA was instantly inactivated. Further exploration of this phenomenon revealed that this inactivation of viral DNA was due to methylation

The recent studies of Richard Flavell and his collaborators at the National Institute of Medical Research, London, and Biogen at Boston, (*Cell* **34**, 197) indicate that it is methylation in the control regions which 'switch off' genes. Methylation of the gene in itself is of no consequence The control region after addition of methyl groups changes the twisting properties of the DNA molecule.

Twisting is indispensable for gene regulation because if a gene is to be recognised by the enzyme that reads it, the double helix must be untwisted to expose the inner chemical sub-units for either replication or transcription to commence Left to itself, DNA snaps back into a right-handed helix which is insubmissive to transcription. In the cell, DNA is wound around DNA-binding proteins, histones which make it more resistant to untwisting. Histones, in association with DNA constitute the nucleoprotein fiber, chromatin. Electronmicrographs reveal that chromatin has a beaded structure, each bead being 100 Å in diameter. Cellular DNA is wound around these spheres, also called nucleosomes, first suggested by R. Kornberg in 1974. But certain regions of DNA are free of nucleosomes and among these are gene controlling regions. Thus the control regions are relatively free to untwist. This raises two questions: what is achieved by untwisting and where does methylation come into the picture?

The answer to the first question appears to be that DNA in cells is in the negative supercoiling state. This condition tends to push the right-handed DNA helix into left-handed coils. From where this tension comes, nobody knows yet, but negative supercoiling is known to be essential for activating genes in prokaryotes and more recently has been shown to act on eukaryotic DNA as well. In relation to unconstrained control regions, the negative supercoiling stress may be released as energy for untwisting.

How this *rara avis* is affected by methylation, nobody knows but results published in a recent issue of *Nature* (**303, 674**) by Alexander Rich and his colleagues of Massachusetts Institute of Technology, U.S.A., provide some insight into the phenomenon of gene regulation and role of methylation in it. They have been working on a control region in the DNA of virus SV40. The regulatory regions of viral DNA are of interest because. First, some viruses are active only in particular cell types, suggesting that their control regions have something in common with the host DNA Secondly, control DNA with properties similar to SV40 DNA has recently been discovered in animal cells where it regulates the production of antibodies. This distinct region is known as an 'enhancer sequence' as it seems to be capable of intensifying the activity of surrounding genes. What Rich and his colleagues have now discovered about the SV40 enhancer is that it is highly susceptible to methylation and when methylated, may forestall negative supercoiling from unwinding the DNA. This property depends on the simple structure of a part of enhancer DNA, made up of a repetitive pattern of alternating cytosine (C) and guanine (G) bases. The significance of this arrangement (CGCGCG) is that the methylating enzyme functions only when cytosine is followed by guanine. The second important characteristic of the CGCG sequence is that it is capable of forming a left-handed double helix known as Z-DNA. It was found by Garry Falsenfield and his colleagues, that if the CG repeating sequence is methylated, it could form Z-DNA in the natural state.

Rich and his colleagues have also shown that under supercoiling stress, the enhancer region of SV40 will flip into Z-DNA Based on these facts, it is speculated that if the enhancer region is unmethylated, it will not form a stable Z-DNA inside the cell under natural conditions. This can release the supercoiling stress arriving at the nucleosome-free control region as an unwinding force. On the other hand, if the enhancer is methylated, the negative supercoiling stress can be absorbed by the change of handedness as the enhancer will flip into Z-configuration and will not be available for untwisting. In this way methylation seems to contribute to gene regulation.

Tariq M. Haqqi

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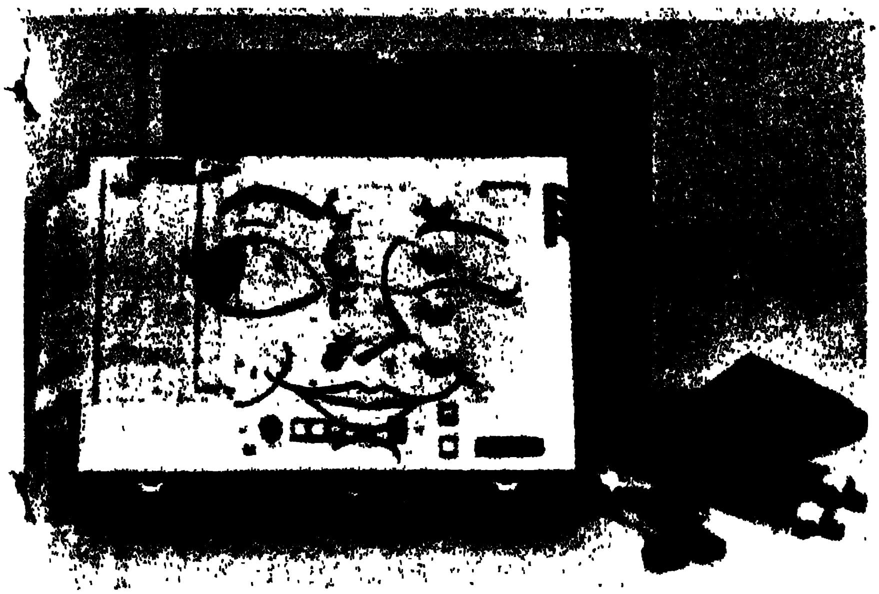
Does the lie-detector tell the truth?

STATISTICS have been described by Disraeli as lies, damn lies and statistics, in that order. It appears that statistics has taken an exception to this and retorted by giving a lie to the lie detector. The lie detector or 'polygraph' to name it scientifically, is an electrical instrument designed to find out if a person is telling the truth or lying.

The polygraph consists of devices that measure the breathing rate, the depth of respiration, the heart rate and blood pressure, and the resistance of the skin to electric current. The basic assumption is that significant deviations in these parameters will be produced by the emotional stress caused by the process of lying. The use of this machine has been controversial



and critics have argued that the very process of being subjected to such a test can cause sufficient emotional stress. Additionally, no two persons would react in an identical manner to the same stressful situation. The proponents counter that a skillful operator, coupled with an impartial interpreter who is not involved in the 'interview' per se can provide infallible results. It is precisely this latter point which has been addressed to by Benjamin Kleinmuntz and Julian Szucko of the University of Illinois at Chicago (*Nature* **308** 449).

The researchers subjected 50 confessed thieves and 50 innocent but suspected thieves to the polygraph test. The data of each of these 100 truthful and untruthful suspects were then randomly assigned to six different professional interpreters. In addition, data from 20 unverified cases were also assigned to simulate actual field conditions. The data were also independently digitised and electronically processed. This was then statistically analysed to determine if the data did contain adequate information to discriminate lies from truth. The verdicts of the interpreters were then compared with that of the electronic analysis as well as the preverified information.

The results were quite revealing. While the interpreters were right on the mark and performed favourably in comparison to the electronic systems in identifying valid positives, their performance in detecting valid negatives was woefully inadequate. The false positives were alarmingly high. In other words, they labelled an innocent as guilty too often for comfort. Furthermore, the inter-judge reliability was also poor. Two interpreters agreed about a verdict a maximum of only 50 per cent of the times. The authors conclude, therefore, that the lie detector tells the truth, provides more than adequate tell-tale information but it is the human interpreter who cannot use it optimally.

What are the alternatives then? A return to the third degree? Well, one doesn't have to be that desperate. The polygraph test combined with the guilty-knowledge test employed by several researchers might do the trick—provided, of course, this too is put to the acid test— that of statistics. *Vive la* statistics!

Bal Phondke

Ultrasound tomography: bliss to doctors and engineers

COMPUTER-aided tomography popularly known as CAT scanning, is not going to be confined to the doctor's office only. It is making in-roads in the petroleum engineer's laboratory too, thanks to a recent advent of a mathematical algorithm used in ultrasound tomography. Research done at Schlumberger-Doll, at Connecticut, USA, which was undertaken to help the core analysis by a rapid and non-destructive method, may lead to the production of clear images of the human body with tomography. This would be based not on X-ray radiation but on ultrasound high frequency waves inaudible to humans.

In fact, ultrasound tomography was thought to be useful in measuring *in situ* saturations of oil and water in deep reservoirs, and thus economise on the time and money involved in core analysis. One of the major advantages of the ultrasound CAT is its non-destructive nature and safe operation without any side effects in comparison to the CAT of X-rays. Since its inception in the late 1960's, CAT has revolutionised medical diagnosis by providing amazingly clear images of the internal organs and fleshy tissues in cross-sections of the human body.

The currently used scanners produce the images by passing X-rays through the patient's body and then combining the different X-ray shadows into a single picture. This is achieved by a mathematical algorithm, which was originally written by the Australian mathematician Radon in early 1900's and which was mainly refined and adapted to medical imaging in 1971 by two Indians, Ramachandran and Lakshminarayanan. Because of the hazardous nature and alarming side effects of repeated doses of radiation in X-ray CAT scanning, doctors are rather concerned about such scanning and reluctantly advise its use in routine check-ups.

Fortunately, ultrasound waves are not only relatively easy and inexpensive to generate and control but are also rarely harmful and do not have any side effects in healthy human tissues. Initial efforts to replace X-rays by ultrasound waves in tomography were abortive since the images produced by the latter were blurred and difficult to read. The principal reason for blurring was that X-rays travel in straight lines whereas ultrasound waves are easily deflected from their original straight paths during their passage through the body. This scattering or diffraction causes defocussing and hence blurring of the images.

It is here that the work done at the Schlumberger-Doll Research Center is going to provide a major breakthrough (*Physics Today*, S-38, 1984). Dr. A. J. Devaney showed that images produced from the ultrasound scan when processed by his new algorithm could be superior to similar images obtained from conventional X-ray scans. The new algorithm has been named as backpropagation, in analogy to backprojection in simple X-ray tomography. Apart from human bodies for routine diagnosis, the ultrasound CAT will be used to measure the amount and distribution of oil and water in the tiny pores in reservoir rocks. This kind of CAT may soon be used in other engineering disciplines too, like chemical metallurgical, civil, etc.

C. D. Yadav

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ARE BETTER MONSOON YEARS AHEAD ?

P.K. Misra

THAT winter of 1982 was the cruellest that north India faced. Cold waves, rain, snow and hailstorms swept the land in rapid succession. Even in May, when the heat would normally be scorching, there was a virtual return of winter with sharp showers, snow, hail and cold winds blowing again; the first half of the month indeed turned out to be the wettest fortnight in the region in a century.

Paradoxically, the monsoon that followed was poor, and over half the country received deficient rains. The drought was one of the worst in several decades, said the experts. And as if this was not enough, the winter of 1983 saw the rabi crop in north India badly damaged by cold spells, rain, snow and hail.

The weather was behaving erratic, and it set economic planners worrying: was the weather cycle changing forever over this part of the globe? The Government of India then appointed a committee, headed by Prof. Yash Pal, Scientific Adviser to the Planning Commission, to study the question. But the committee found the changes in the weather pattern more apparent than real.

The fact, however, is that the climate is never static. Every decade and every year differs from another in random fluctuations, though there is a broad trend underlying these fluctuations. To understand this trend is important for planning for the future. Looking at the past trend, and considering all the factors that influence rainfall, India can possibly look forward to excellent monsoon conditions during the 1990s after a prolonged bad patch from 1965 onwards.

Basically, the climate depends on the Sun. With a view to discerning the climatic changes of the Earth, climatologists have in recent years begun an intensive study of the temperature changes on the Earth. This study had revealed that the Earth had warmed up slightly from the late 19th century upto the 1940s and cooled subsequently upto the 1970s. The worldwide average temperature rose by about 0.5°C (the average global surface temperature is about 13°C) from 1880 to 1940 and has fallen by 0.1° to 0.2°C since then. Climatologists had, till now tried to explain these temperature trends on the basis of two processes: (i) the warming caused by the increasing carbon dioxide build-up in the atmosphere (the greenhouse effect), and (ii) the variable cooling effect produced when great volcanic eruptions spread dust high into the atmosphere, blocking some of the heat from the Sun from reaching the Earth (volcanic eruption effect).

Consequent of our increasing use of fossil fuels like coal and oil, carbon dioxide has been accumulating in the atmosphere. When these fuels are burnt they produce carbon dioxide which is released into the atmosphere. This carbon dioxide lets in the short-wave radiation from the Sun, but it traps the long-wave radiation (infra red) emitted from the Earth's surface,

India can possibly look forward to excellent monsoon conditions during the 1990s after a prolonged bad patch since 1965

thus warming up the lower atmosphere; this is the so-called "greenhouse effect". Standard climatic models suggest that doubling the concentration of carbon dioxide in the atmosphere will warm the Earth by about 2°C. Scientists say that by now the carbon dioxide in the atmosphere has gone up by over 10 per cent of the level since 1890, nearly half the increase having occurred after the Second World War. If the standard calculations of greenhouse effect are taken as correct, it is apprehended that over the next 30 years the Earth's temperature is likely to rise by a full degree centigrade, unless other processes counteract this everincreasing influence.

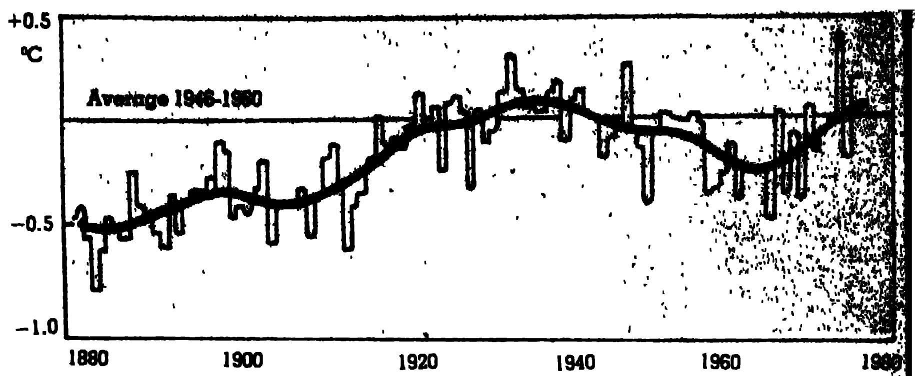

Fig. 1 The warming trend in the northern hemisphere

Volcanic eruptions have an opposite effect on the climate. The great volcanic eruptions spread dust high into the stratosphere (layer of the atmosphere extending from about 13 km to 56 km). In course of time, this dust envelops the stratosphere and blocks some of the solar radiation from reaching the Earth's surface. The greatest known volcanic eruption, that of Tambora in Indonesia in 1815, had belched 80 cubic kilometres of ejceta into the upper atmosphere. This volcanic eruption produced what climatologists called the 'year of no summer' in the New England area of the United States and brought ice to London's Thames River. The great eruption of the Krakatoa volcano in August 1883 had reduced the incoming radiation by as much as 25 per cent. Eighty years later, the Mount Agung eruption in Indonesia in March 1963, climatologists believe, eventually contributed to the severe winters in the northern hemisphere in the mid 1960s. The explosion of the Chinchonal volcano in southeast Mexico on 4 April 1982 had again thrown millions of tonnes of debris into the upper atmosphere. The dust cloud extended in a band around the world, including over India, according to US scientists. This dust cloud, according to them, is likely to produce climatic changes similar to those observed after such eruptions in the past.

Fig. 2 The Krakatoa volcano in Indonesia erupts, throwing enormous amount of lava, ash and mud into the atmosphere. The dust, spreading very far, reduces the amount of solar radiation that reaches the Earth

Since the early part of the present century was quiet in terms of volcanic eruptions, the warming trend observed during this period can be said to be a result of dust clearing from the stratosphere. Similarly the recent cooling trend can be explained on the basis of the increasing volcanic activity. But in this scheme, the influence of carbon dioxide does not fit in. According to most climate modellers, the carbon dioxide-induced warming would have dominated the volcanic influence and caused the Earth to continue warming after the 1940s. What other factor is at work then?

In 1979, Jack Eddy of the High-Altitude Observatory in Boulder, USA, dropped a bomb-shell that the Sun was shrinking. The shrinkage was at such a rate that if it continued the Sun would disappear within a hundred thousand years. Evidently, Eddy's discovery implied that the Sun is merely in a temporary phase of contraction, which

How does a forecaster predict the daily weather?

WEATHER forecasting is vital to shipping, aviation, agriculture and many other economic actities Weather prediction techniques can be divided into two parts

(i) Weather analysis, that is, the re construction of the current situation on the basis of thousands of surface and upper air meteorological observations taken simultaneously all over the world and exchanged between different forecasting centres with the help of fast telecommunication channels These observations are plotted on various charts which are analysed, the forecas ter delineates areas where the lower atmosphere shows the presence of vertical motion marked moisture flux and atmospheric instability These factors are essential for the development and growth of rain-bearing clouds

(ii) Weather prediction using certain techniques not strictly based on any general theory Even today, virtually all prediction methods used are a mixture of subjectively assimilated experience, piecemeal statistical relationships and a certain amount of physical reasoning, there is no single consistent set of rules for judging Indeed the art of weather forecasting is not exactly scientific even today

From a theoretical point of view if the initial state of the atmosphere and the laws that govern its motion were known, the future behaviour of the atmosphere can be predicted by mathematical deductions The set of hydrodynamic equations which govern atmospheric motions has been known since early in the nineteenth century and as early as in 1858, the German hydrodynamist, von Helmholtz, studied them as a possible means of dealing with meteorological problems But the equations were too difficult to solve analytically A turning

Satellite pictures of the Andhra Pradesh cyclone as it developed and moved inland on 4 and 5 October 1983

point in the development of numerical weather prediction was the meteorologist's realisation that the general hydrodynamical equations could be solved in principle by purely numerical methods L F Richardson, a British meteorologist, designed and carried through a finite-difference scheme for solving the non-linear hydrodynamical equations for meteorological purposes

This was the first genuine attempt at dynamical weather prediction In this Richardson encountered two formidable difficulties First the computational work was so great that there could be little hope of producing timely forecasts Richardson himself had estimated that it would take about 64,000 persons using table calculators just to predict weather as fast as it developed in nature, let alone gain on nature Second, Richardson's equations were oversensitive and even slight errors in the initial conditions would lead to large errors in predictions

The major difficulties have now been circumvented Methods have been found to remove the oversensitivity of the prognostic equations, and the development of computers had solved the calculation problem

The oversensitivity of the prognostic equations were removed by a judicious use of the so-called "geostrophic approximation', first introduced by the British meteorologist, J G Charney. The atmosphere is always very close to a state of mechanical equilibrium and hence the horizontal pressure-gradient force is almost exactly in balance with the Coriolis force arising out of the rotation of the Earth This semi-empirical relationship—the so-called 'geostrophic wind approximation"—is invoked frequently in meteorological argument The simple dynamical model adopted by Charney could predict the behaviour of the largescale atmospheric disturbances with an accuracy comparable to that attained by an experienced weather forecaster But Charney's simple model could only predict how a disturbance moves once it is formed but not the formation and growth of new disturbances, which are the essence of all meteorological forecasts Many more general models have since been proposed, some of them capable of predicting growth of weather disturbances as well Today many dynamical modellers claim

A radarscope picture of a cyclone

that the relatively crude methods of dynamical weather prediction are already as effective as the subjective techniques used by skilled forecasters In their opinion they are accurate enough to justify putting them into practice

In India, the application of numerical models in day-to-day forecasting is beset with many problems First, the so-called "geostrophic assumption" does not strictly apply to the tropical region of the Indian subcontinent. Second, the computer requires a set of initial values

of various meteorological parameters at a network of discrete points filling the entire area for which the prediction is to be made. Although upper-air observations are now much more frequent, more dense and more accurate, Indian meteorologists are still confronted with the problem of inadequate data from the vast oceanic areas surrounding the country and also from countries beyond our western frontiers. Major weather-producing systems like depressions, cyclones and hurricanes form and intensify over the oceans but dynamical modellers have to depend entirely on the manipulated data fed to the computer for the vast oceanic area. Over the Atlantic and the Pacific, observations recorded by weather reconnaissance aircraft are utilised over such data-sparse regions. Nevertheless, the various prognostic weather charts issued daily by the numerical weather forecasting division of India Meteorological Department serve as a powerful feedback in complementing the existing conventional weather prediction techniques.

The cloud photographs received day and night from the polar orbiting satellites as well as geostationary satellites enable the forecaster to maintain a constant vigil over the formation, intensification and movements of tropical cyclones. India's own geostationary satellite INSAT-IB sends pictures of the atmosphere every half-an-hour. Eight cyclone detection radars installed on the east and west coasts watch for any possible threat from cyclones and hurricanes.

Satellite pictures show the distribution of clouds over a region, and by studying a sequence of such pictures one can work out how fast the clouds are moving. One can also calculate the sea surface temperature from satellite pictures; the sea surface temperature influences the development and movement of clouds. However, satellite pictures can help in estimating wind velocities in only those atmospheric levels where clouds are formed. If there is no cloud, one cannot deduce wind velocities from the pictures.

P. K. M.

must soon be halted and reversed. Close on the heels of the startling claim by Eddy, David Dunham and his colleagues in the USA concluded in December 1980 that between 1715 and the 1970s the Sun had shrunk by 0.34 second of arc (the Sun has an angular diameter of 32 minutes of arc) and that between 1976 and 1979 there was no measurable change in the solar radius. Simultaneously, John Parkinson and his colleagues in the UK suggested that the Sun's size varied with a cycle of about 80 years. And then in 1981, Ronald Gilliland, USA, concluded from a battery of statistical tests that there was an overall decline in the solar diameter of about 0.1 second of arc per century since the early 1700s. By resorting to standard statistical tests aimed at revealing small and regular changes in the pattern of variability, he also showed that the periodic variation in the Sun's radius repeated in a cycle of 76 years. This almost exactly fitted with the periodic variation suggested earlier by Parkinson.

The best fit between theoretical calculations and actual observations is obtained if this factor, the solar variability, is incorporated in the model of global temperature variation. As the size of the Sun varies, so also its heat output. Gilliland's model suggests a 24-year lag between the maximum of solar size and the peak warmth produced by it on the Earth (just as 22 June is the day of longest sunshine but the maximum warming of the northern hemisphere occurs much later because of the cumulative addition of heat, the day being greater than the night). The warming trend during the early part of the century is now explained to have been caused by a combination of solar and volcanic influences.

During the first four decades of this century, for instance, western Europe experienced less severe winters. By 1938, the ice cover over the Arctic Ocean had retreated farther north than ever before in modern times. The dustbowl in North America during the 1930s was the result of a combination of these two factors. From about 1940 to 1970, both the solar and volcanic influences were acting to cool the Earth. And this cooling was more than compensating the warming produced by the rapid build-up of carbon dioxide. There had been a sharp increase in the frequency of severe winters over Europe since about the 1940s. The extent of ice over the Norwegian and Barents Sea had also started increasing since about 1940 and by 1962 its extent in this sector was apparently greater than at any time since the 1880s.

The Indian summer monsoon and the solar cycle

In this century the Sun had attained the maximum of its 76-year cycle of variability in 1911 and a minimum in 1949. The peak warmth produced due to the maximum solar diameter was around 1935 (because of the 24-year lag mentioned earlier) and the maximum solar cooling due to the minimum solar diameter was around 1973. Figure 5 shows the schematic variation of global temperature associated with this solar cycle alone for the period 1860 to 2010. The number of subdivisions (in per cent) in India which experienced deficient or scanty rainfall during monsoon months from 1875 to 1983 has also been plotted in the same figure.

The period 1916 to 1954 saw a warm solar epoch and another warm epoch is to commence from 1992 onwards. The warm epochs cause a general strengthening of the circumpolar westerlies (the so-called strong zonal circulation) because of the increased availability of solar energy (Fig. 3). During the period of strong zonal circulation the subtropical anticyclones develop more intensely and move toward higher latitudes compared to its normal position (30-35°) North or South latitude (also known as Horse latitude). Relatively long, small-amplitude waves which characterise the circumpolar westerlies during the period of strong zonal circulation remain restricted to mid-latitudes only (Fig. 4a). Troughs in circumpolar westerlies do not extend very far south into the subtropical

latitudes. A smaller number of "western disturbances" [low pressure areas which generally form over the Mediterranean come over north India after crossing Iraq, Iran, Afghanistan and Pakistan and then move away further eastwards across the Himalayas. Though on occasion they appear as cyclonic circulations (circulation rotating in the anticlockwise direction in the northern hemisphere) in the troposphere, they generally come over India in the form of troughs in the circumpolar westerlies (Fig. 4). In association with these disturbances, north India experiences rain, snow and hailstorms during winter, pre-monsoon and post-monsoon months. If they come over India during monsoon months, they generally lead to the stoppage of rainfall over central and north India] move across north India

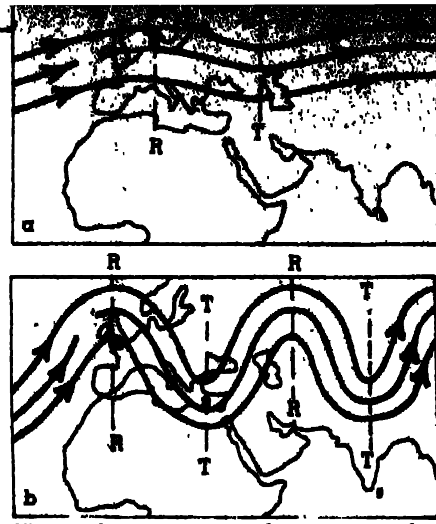

Fig. 4 The extreme circulation types. The circumpolar westerlies do not blow as straight currents but show wavelike oscillations marked by troughs (T) and ridges (R). (a) Strong zonal circulation allowing monsoon rains to extend well to the north. (b) Weak zonal circulation suppressing the northward extent of monsoon rains

during the winter. This leads to decreased winter precipitation over north India and the Himalayas. In the tropics, the meridional circulation (Fig. 3) becomes strong and extends well to the north. Consequently, the monsoon season gets prolonged and more rains occur over the tropics. Thus it is seen that winter rains (December to February) and summer monsoon (June to September) rains over the tropics and the adjoining sub-tropical region are negatively correlated, that is, good winter rains will mean poor rains in the summer monsoon. An analysis of the rainfall records of India from 1875 to 1970 had also shown that the winter precipitation over northwest India is negatively correlated to summer monsoon rainfall in both northwest and peninsular India. Henry F. Blanford (the then chief Meteorological Reporter to the Govt. of India) had postulated as early as 1884 that an unusual amount of precipitation over northern India and the Himalayas in winter may cause the succeeding summer rainfall to be poor over India. Since the monsoon rainfall forms the bulk of the annual rainfall in India, a good winter precipitation is generally an ominous sign of a bad monsoon. The year 1982 proved to be a striking example.

Figure 5 shows that during the 34-year warm period from 1921 to 1954, there were only four occasions when more than 30 per cent subdivisions received deficient rainfall. The good rainfall period extended further upto 1964 even after the beginning of the cold solar period from 1955. In fact, the years 1942 to 1950 and from 1953 to 1964 have been the best years of monsoon rainfall in the 109-year period (1875 to 1983).

During the last one century, there were two cold epochs—1878-1916 and another that started in 1954 and expected to last till 1992 (Fig. 5). The cold epochs cause a general weakening of the circumpolar westerlies (the so-called weak zonal circulation) because of the reduced solar energy supply. During the period of weak zonal circulation, the sub-tropical anticyclone is less developed and moves very much south of its normal position. Relatively short, large-amplitude waves develop in the circumpolar westerlies and the

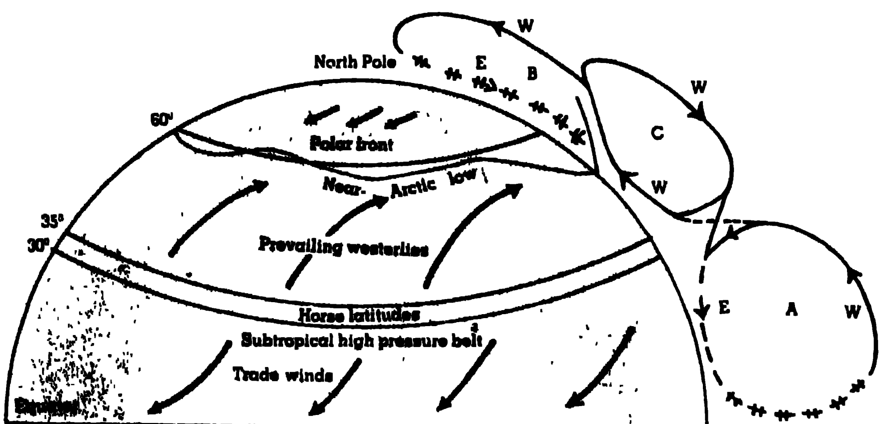

Fig. 3 Wind blows from areas of high atmospheric pressure to those of low pressure. There is a low-pressure belt about the equator and two low-pressure belts around the Arctic and Antarctic circles. There are two high-pressure belts at about 30°-35° north and south of the equator known as subtropical highs or sub-tropical anticyclones. In the northern hemisphere, northward and southward moving currents get transformed into westerly and easterly winds respectively due to the rotation of the Earth. Westerly winds which blow from the subtropical anticyclones towards the Arctic and Antarctic low-pressure belts are known as circumpolar westerlies. The tropical meridional (north and south) circulation cell extends from the equatorial low-pressure belt to the subtropical high-pressure belt. Considering the northern hemisphere, warm and moist air rises near the equatorial low-pressure belt, moves aloft northwards as south winds, descends near the subtropical high-pressure belt as cold and dry air and then moves towards the equatorial low-pressure belt as low level northerly winds A: the tropical meridional cell (Hadley Cell). B: the polar front cell. C: middle latitudinal cell. E: easterly winds, and W: westerly winds

strongest westerly flow tends to flow at comparatively low latitudes (Fig. 4b). The troughs in tropospheric westerlies extend into the sub-tropics and even into tropical latitudes. A greater number of "western disturbances" move across north India during winters leading to increased precipitation over northwest India and a greater snowfall over the Himalayas. South of the subtropical anticyclone, the tropical meridional circulation contracts and the monsoon rains do not extend far north. As the rains in many subtropical regions are associated with the seasonal migration of the equatorial rainfall belt, the narrowing of this rainfall belt causes many rainfall seasons to become shorter.

During the first cold epoch (1878-1916), India experienced a number of severe droughts between 1891 and 1915 (Fig. 5). This dry spell actually extended upto 1920. During the 30-year period from 1891 to 1920, there were 10 occasions when monsoon rains failed over more than 30 per cent sub-divisions. The tropical rainfall also decreased abruptly at the end of the 19th century over tropical Australia, parts of the Pacific, Colombia, Mexico, north-east Brazil, the Caribbean, Africa, southwest Asia and Ceylon. This widespread drought lasted—with some interruptions—at least for 15 years.

Similarly, in the current second cold epoch (1954-1992) also there had been several largescale failures of monsoon rainfall over India between 1965 and 1982. Out of a total of 35 sub-divisions, rainfall deficiencies occurred in 11 to 14 sub-divisions in 1965, 1966, 1968, 1974 and 1982, in 17 sub-divisions in 1979 and in as many as 21 sub-divisions in 1972.

The next two decades

The solar diameter is approaching another maximum in 1987. This will contribute to warming the planet upto the year 2010 which will, in turn, add to the everincreasing greenhouse effect. The combined warming influence is likely to cause during the 1990s a return of the excellent climatic condition for agriculture that prevailed over

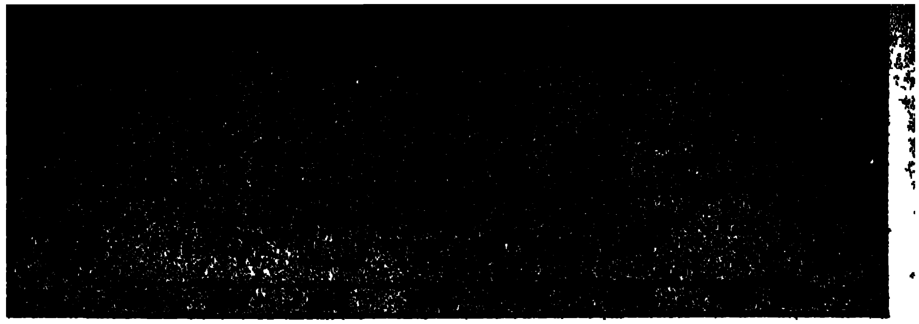

Fig 5 The sinusoidal curve represents the schematic variation of global temperature (not to scale) associated with the solar cycle. The number of sub-divisions (in per cent) in India receiving deficient rainfall since 1875 has also been plotted

India during 1921 to 1954. India can possibly look forward to an excellent monsoon condition during the 1990s.

A look at Fig. 5 will show that the bad monsoon years which started towards the middle of the first cold epoch around 1891 continued till 1920, even after the beginning of the warm epoch in 1916. If we assume a similar trend during the current cold epoch, monsoon rainfall over India may turn out to be somewhat deficient till 1990. But the everincreasing greenhouse effect consequent of carbon dioxide accumulation may however hasten the return of good monsoon years even before 1990. However, there is always a certain amount of uncertainty in any long-range prediction. After the eruption of the Mexican volcano in 1982, many experts predicted a fall in world temperature in 1983, but 1983 proved to be the fourth warmest year on record, 1981 being the warmest year ever recorded in the northern hemisphere. And contrary to the prediction of many weather experts, 1983 proved to be an excellent monsoon year for India and the country harvested a record foodgrain production of nearly 150 million tonnes in 1983-84. (India Meteorological Department had predicted normal monsoon rainfall over India during 1983)

The warming influence of the increased solar diameter is now in consonance with the greenhouse effect whereas during the past 30 years they had been counterbalancing each other. The combined influence, it is apprehended, might give rise to a much more rapid and pronounced warming of the Earth than has previously been thought likely. Beyond the turn of the century, this rapid warming may lead to conditions hitherto unseen on the Earth. So far the Earth had experienced a maximum fluctuation of about +0.4° Celsius about its mean temperature. A further rise by another 0.2° may lead to catastrophic results. If the mean temperature of the Earth increases by as little as one degree Celsius from its mean value, ecologists warn that a cataclysmic chain reaction will be set in motion: the polar ice caps will start melting; consequently, the ocean level will rise so much that all coastal cities will get submerged in course of time; and weather conditions will change so drastically that all plant and animal life will be severely affected and many fertile lands will turn into deserts.

The weather over different parts of the globe undergoes seasonal changes with the movement of the Sun. The global atmospheric circulation pattern always adjusts itself in such a manner as to minimise the glaring disparity between places. During summer when the temperatures reach unbearable limits over any part of the globe, processes like blowing of cool breeze, rain, thundershowers, etc are set in motion to minimise the thermal effect. To summarise, we can say that nature devises means against abnormal environmental changes. At the turn of the new century, as the Earth approaches a superthermal state, processes may start working to bring it back within permissible temperature limits. Severe volcanic eruptions and earthquakes are the two processes which can help cool the planet. Will our planet face a chain of severe volcanic eruptions and earthquakes with the turn of the new century?

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COOKING A PROGRAM

S. Arun-Kumar **R. Chandrasekhar** **Kamal Lodaya** **Paritosh Pandya** **R. Ramanujam**

WE now have a general idea of what a computer is and what it can do. The next obvious question is—how to make the computer do what we want? In other words, given a problem how do we attempt a solution with the help of a computer?

This process is called programming. The programming process involves three phases of activity:
(i) formulating the problem precisely
(ii) envisaging the solution to the problem as a sequence of actions
(iii)translating these actions to instructions executable by a computer.

The second phase, known as **algorithm development,** forms the central part of this activity. We shall first see what algorithms are before going to each one of the above in detail.

An algorithm is a method, outlined as a sequence of steps, to arrive at the solution to a given problem. For example, to find the number of days between 15-Feb-1984 and 21-Mar-1984, one could use the three-step algorithm:

- ☐ Find the number of days after 15-Feb-1984 before 1-Mar-1984;
- ☐ Find the number of days after 29-Feb-1984 before 21-Mar-1984;
- ☐ Add the two to get the answer.

To devise an algorithm, we need neither a computer nor a programming language. Indeed, mathematicians have been familiar with the notion of an algorithm for centuries. The word *algorithm* is derived from Al-Khwarizmi, the eminent ninth century mathematician and author of *The Astronomy Tables, Arithmetic* and *Algebra*. In fact, we devise algorithms frequently in everyday life. For example, to cook pulao for 10 people, a housewife may use the following algorithm (recipé).

Wash 5 cups of rice and drain the water;
Cut the vegetables;
Take 4 tablespoons of ghee and fry the vegetables with garam masala;
When the vegetables are quarter done add rice and fry some more;
When the mixture starts leaving the pan add 8 cups of water, salt and a pinch of turmeric and cook;
Garnish with fried nuts and raisins.

Another familiar example of an algorithm is the use of a route map to find directions to a destination. An important characteristic of an algorithm is that it guarantees the required result in a finite time. Expressed in computer science parlance, an algorithm should, by definition, **terminate.**

We can say, briefly, that an algorithm is nothing but a computational method or a procedure to carry out the required task. To use the most efficient algorithm for the given problem would be the aim of a programmer. With this idea of an algorithm in mind, we analyse the programming process.

Problem specification

The most important and perhaps the most difficult step in programming is formulating the problem precisely. Programmers find that many of their troubles arise from the fact that the specification of the problem is incorrect, ambiguous or incomplete. When we say that a program works, we only mean that it works within some given specification. Once the specification is changed the program may become quite useless.

Consider the algorithm for making pulao. We know that it works when we have 10 guests, but if we change the specification and attempt to feed 100 people, it does not work at all! We can of course change the program to work for feeding N people, where the value of N is taken as input at the time of execution. However, when we want to cook pulao for 500 people, even the method of preparation may change drastically. For example, instead of frying the vegetables and rice one after another and then cooking, we may have to cook together rice and vegetables in a huge vessel, and then fry it. Indeed, this problem is fairly common in Computer Science, particularly so in business data processing: as the volume of data increases, the structure of algorithms may also change.

In fact, the specification for the pulao program is rather incomplete, because it just says "pulao has to be served for 10 people", without specifying when (after all, nobody is going to wait too long for the pulao to get ready). If it has to be ready within say, twenty minutes, the program simply does not work! To do the job fast, one may need several vessels and cook on many stoves in parallel and employ more than one person to cut vegetables. Such **distributed** solutions are common in Computer Science, where many programs are executed in parallel to carry out a task.

Thus, problem formulation includes the specification of available resources and expected performance levels. Then we go on to design algorithms which use only available resources and meet the performance requirements. Analysing a program to find out how much time it would take to execute on any given computer and what resources it would need is known as **complexity analysis.**

In general, how do we go about writing proper program specifications? There are no clear cut rules for this, but an example might help. Let us write a program that goes through a list of students and their marks to pick the student who has got the maximum marks. Let us attempt a precise specification for this program. The statement of the problem should be as unambiguous as possible (some formal language like mathematical logic may be needed for stating the problem).

We spell out the problem explicitly in the following terms.

A) Let L be the list of students and marks. Symbolically we write L=<N,M> where N is a student's name and M is N's marks. The problem is to find x such that <x, max> is in this list and is also such that max is the highest marks in the list.

Obviously the data needed is the list

L. Further, we have to specify the source and form of data clearly:

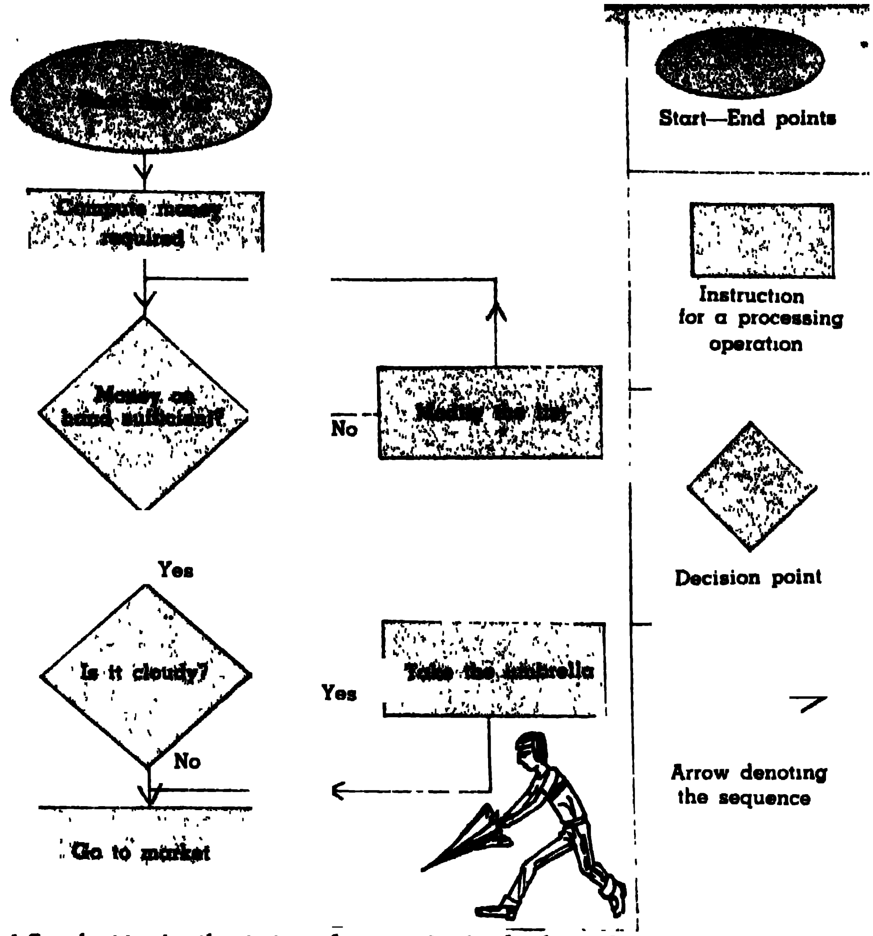
B) The data file STUDENT contains the list L. Each element of L is in the form: a 30-letter name, followed by 3-digit marks.

The output needed has also to be explicitly specified:

C) Type the name and marks of a student who has scored maximum with a suitable message.

(Note that the specification is unfair in a sense—even if many students have scored the highest, only one name gets printed!)

The specifications should also include details of what should be done in case the required information is not available:



A flowchart tracing the strategy of a person leaving for the market

D) If the STUDENT file is empty or if it contains data not in the specified form or if any student has marks more than 100, print an error message.

It is sometimes necessary to specify performance requirements like speed, memory required, frequency of program usage, volume of data etc. For our example, however, we may like to specify a different type of efficiency requirement:

E) Once a student is found to have 100 marks, stop processing.

Specifications also serve documentation purposes. When different persons of a programming team work together on a package (a set of programs for one application), the specification provides a way of communicating details about the program. For large application programs in business data processing, it is common for the systems analyst to write the specifications while several programmers write the programs. Further, program specifications serve as a contract between the programmer and the user and play the role of an arbitrator in any argument between them.

Flowcharts and Algorithmic languages

Once the problem specifications are made clear, we start thinking about a solution. One question arises immediately; after we formulate a solution, how are we to articulate it as a sequence of actions?

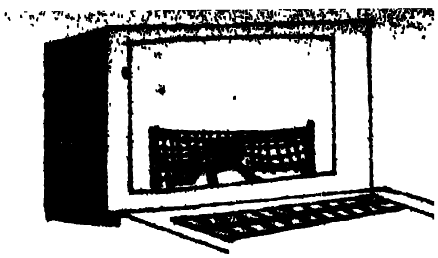
Our first step is to classify the data into two groups. Those whose values are known and those whose values are unknown. With each unknown, we associate a variable with a suitably chosen name. Any data whose value is known and remains unchanged is called a constant. A variable may be thought of as a memory location which holds different values at different times. If X is a variable and V is any value, we shall use the notation.

$$X \leftarrow V$$

to denote that whatever value was present in the location X is erased and a new value V is put in. This is called **assignment**. What if we have data items which require not just one location, but many? In such a situation, it is customary to use **array** variables—an array is a sequence of locations referred to by a single variable name. If MARKS is an array variable, we write MARKS (1) to denote the first element of the array, MARKS (5) to denote the fifth element and so on. In fact, MARKS (J) will denote the Jth element in the array. J is called an **index** variable—of the array MARKS.

The actions or operations to be executed are specified in terms of the variables. Many programmers use flowcharts for this purpose. In a flowchart actions are symbolically represented by boxes and the sequencing by arrows connecting these boxes. Though the boxes are normally square, decisions are distinguished by diamond-shaped ones. Above is an example of a flowchart. Special symbols are used in flowcharts to indicate some other details, which we shall not consider here.

A major problem with flowcharts is that they can be very difficult to understand. It is more so as the size of the program gets large. When flow charts run into several pages one has to pore over a maze of arrows and follow the sequence of operations through complicated routes. When this is the



situation, mistakes can easily creep in. This becomes unavoidable when the program fails to work and has to be looked into and corrected. (In the programmer's jargon, we are looking for a *bug* in the program so that we can *debug* it.)

An alternative approach is to recognise that some basic instruction patterns appear often in flowcharts and to build an algorithmic language using such patterns as basic units (constructs). The main basic patterns we come across are:

- ☐ The conditional execution, where a condition determines which set of instructions is to be executed
- ☐ The iterative execution (commonly called a loop), where a condition determines how many times a given set of instructions is to be repeatedly executed.

The box alongside gives such an algorithmic language and we build our programs based on this.

Algorithmic language

The statements in the algorithmic language are:
Assignment Statement:
variable ← expression
Conditional Statement:
If *condition* then *{statements 1}*
else *{statements 2 }*
If condition is true execute the statements in 1, otherwise execute those in 2.
Repetitive Statement:
while *condition* do *{statements}*
Execute statements inside braces as long as the condition is true
Input Statement:
read from *filename (data-to-be-read)*
Output Statement:
print *(data-to-be-printed)*
Continuation Statement:
skip
Do nothing and move to next statement
Sequencing of statements:
Statement 1: Statement 2
Execute Statement 1 first and then Statement 2
Comments:
(COMMENT some description)
The comment is not executed; it serves only to explain the algorithm.

Planning a program

Now we can write specifications for a given problem and are also familiar with the language constructs into which we need to translate the solution. How do we proceed to the task of finding the solution that meets the specifications? The answer to this depends on the problem-solving methods we resort to.

One of the most important programming strategies advocated in Computer Science is called **stepwise refinement.** We start with a specification, rewrite it as a set of sub-specifications, take each one of these and repeat the process till each line can directly be translated into a statement in the algorithmic language

Let us now return to the student-marks example and write a program

We use two array variables NAME and MARKS, and a variable I to index the arrays. N is a variable which can hold a name and M, marks. Let MAX be the variable which will eventually contain the position of the maximum marks in the array MARKS. TOT will hold the total number of students.

To start with, let us write the problem specification as a set of commands which the computer should execute to find the maximum:

- ☐ Read names and marks from the file STUDENT and store it in arrays NAME and MARKS respectively;
- ☐ Find the maximum value in the array MARKS and put index in MAX;
- ☐ Print NAME (MAX) and MARKS (MAX)

However, the computer cannot execute these commands as they are. So we go on to refine the program by way of breaking up each command into many simpler ones.

First, the third subspecification in the above can be translated into our algorithmic language as:

> Print ("The student who has the maximum marks is", NAME (MAX), "and he/she has got"—MARKS (MAX), "marks")

The first sub-specification can be rewritten as:

> read a student's name and his/her marks into the next available position in the arrays NAME and MARKS
>
> repeat this process until the entire STUDENT file is read

To do this it is necessary to know which locations in the array are available. Initially all these are available and we can start with the first and fill up all the rest one after another.

Since the process has to be repeated till the end of the STUDENT file is reached, the following while loop suggests itself:

TOT ← 0;
while not end of 'STUDENT' file do
{read from 'STUDENT' (N, M),
(COMMENT increment TOT to get next available position)
TOT←TOT+1;
NAME [TOT]←N, MARKS [TOT]←M
(COMMENT TOT has the total number of students in file)

Now we can go about finding the maximum. Let us first write a simpler program.

Given two numbers X and Y, find MAX2 the maximum of the two.

The obvious solution is to compare them and find which is greater.

if X>Y then (MAX2← X)
else (MAX2←Y)

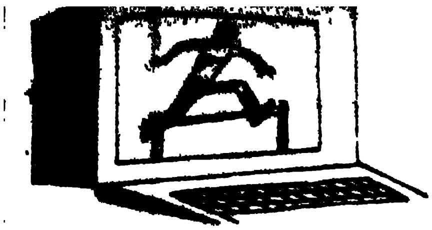
Let us now extend the problem to find the maximum of three numbers instead of two; we need one more statement:

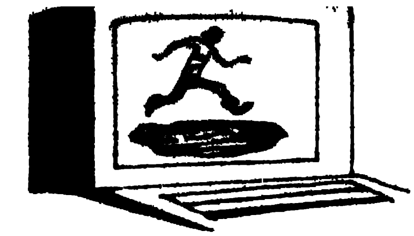
if X>Y then {MAX3←X}
else {MAX3←Y}
if Z>MAX3 then {MAX3←Z}
else {skip}

We compared X and Y, stored their maximum in MAX3 and compared that with Z. This suggests the following strategy for finding the maximum of K numbers:

find maximum of J numbers in MAXK;
if J+1th number> MAXK then {MAXK ←J+1th number}
else {skip}
repeat this process varying J from 2 to K-1

Since the comparison process is the same for the first two numbers as for





the rest, there is no need to compare them explicitly. One way would be to arbitrarily assign the first number to MAX and compare this with the second number onwards.

```
MAX←first number; I←2;
while I≤ K do
{if Ith number > MAX then {MAX ← Ith
number}
else {skip};
I←I+1}
```

As we want to find the *position* of the maximum number rather than the number itself, we use MAX to hold the position of the current maximum rather than the maximum value itself:

```
MAX←1; I←2:
while I ≤ TOT do
{if MARKS [I] >MARKS [MAX] then {MAX←I}
else {skip};
I←I+1}
```

Putting all the parts together, we get the algorithm given in program version I. When we examine the algorithm, we find that only specifications A, B and C have been satisfied. To satisfy the specification D requires some error handling. The refinement of the file-reading part has to be modified to include this. An algorithm including such a modification is shown in program version II. Modifying the program to satisfy the efficiency requirement E would mean changing the structure of the program. This is left as an exercise for the interested reader.

Program: Version I

Variables: I, N, M, MAX, TOT; Arrays: NAME, MARKS;

```
    TOT←0;
Read file:
    while not end of 'STUDENT' file do
    {read from 'STUDENT' (N, M);
    TOT ←TOT+1;
    NAME [TOT] ← N; MARKS [TOT] ← M}:
Find maximum:
    MAX ← 1; I ← 2;
    while I≤ TOT do
    { if MARKS [I] > MARKS [MAX] then {MAX
    ←I}
    else {skip}:
    I ←I + 1}
Print result:
print ("The student who has got the
maximum marks is", NAME [MAX], "and
he/she has got", MARKS [MAX], "marks")
```

Program: Version II.

Variables: I, N, M, MAX, TOT; Arrays: NAME, MARKS;

```
    If 'STUDENT' file is empty then
    { print ('STUDENT file is empty')}
    else
    TOT ←0;
Read file:
    While not end of 'STUDENT' file do
    {read from 'STUDENT' (N, M);
    if M> 100 or data not in form then
    { print ('Incorrect data' N, M,
    '—rejected')}
    else
    {TOT← TOT+1:
    NAME [TOT] ← N, MARKS [TOT] ← M}:
Find maximum:
    MAX ← 1: I ←2:
    while I< TOT do
    { if MARKS [I] > MARKS [MAX] then
    { MAX ← I}
    else {skip};
    I←I + 1}
Print result:
    print {"The student who has got the
    maximum marks is", NAME [MAX], "and
    he/she has got", MARKS [MAX], "marks"}
```

Checking program correctness

The program version II is better than the version I because it also performs input variation checks. However, both of them have a serious bug. *We advise the reader to pause at this moment and try to discover the bug for herself.* The answer and suggestions for debugging are given at the end of the article.

This raises a serious doubt—though we seemed to be proceeding carefully, this bug has crept in! Usually, programmers check their programs by hand for some test cases and then run them on the computer with more test data. In the process, many bugs are weeded out, but some unforeseen ones may arise much later. If it should happen long after the program is written or if the program is very large, the programmer will be put under stress during debugging. This is where the ingenuity and skill of the programmer plays a major part: a good programmer takes into account all possibilities while developing the program.

Such a situation is decidedly intolerable when computers are used in critical applications like missile control, surgical operations in clinics etc. During the 1970s there have been many research efforts towards mathematically *proving* that a written program meets the given specifications. A methodology of programming has also been suggested where the program and its proof are developed hand-in-hand. Attempts are also being made to relegate this job of proving a program to the computer itself. In fact, such **program verifiers** do exist for some programming languages. There are also research efforts where the computer directly reads specifications written in some specification language and attempts to synthesise its own program to solve the problem.

So far we have concentrated in developing programs. Analysing and improving a given program is a more complicated task. We shall tackle this problem in the next article. □

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Bug in the Program

CONSIDER the Program in Version I. When the STUDENT file is empty, TOT, which is initially assigned zero, continues to be zero at the end of the first loop (which is not executed). Since I is 2 and TOT is 0, the second loop is also not executed. Now MAX is 1 and the program attempts to print values of NAME [1] and MARKS [1], which do not exist! Typically, a computer will print whatever junk is present in NAME [1] and MARKS [1].

Similarly, in version II TOT is zero when all data records get rejected. The same bug appears.

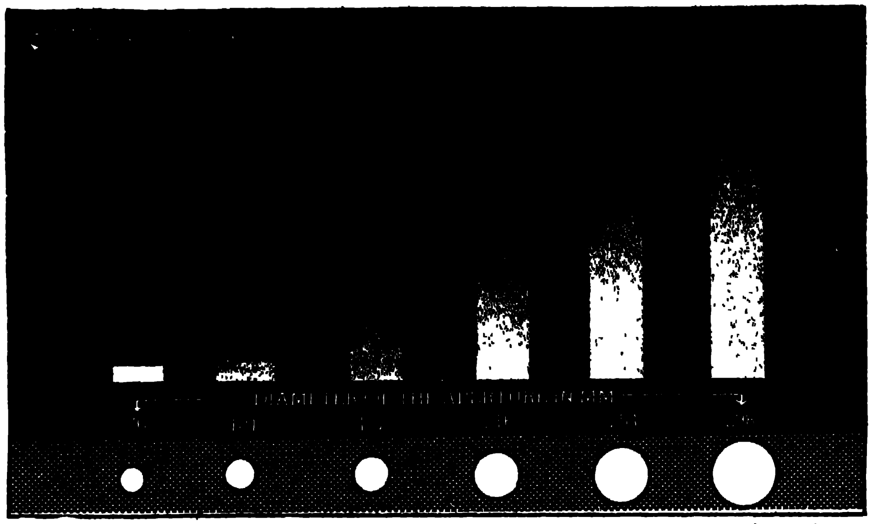
The mistake was that when putting the parts "read file" and "find maximum" together, we did not check that the condition assumed by the latter part, namely TOT >0, was ensured by the former part.

Moral: Whenever, in a specification

S1 S2,

the two sub-specifications are refined independently, check that the assumptions of S2 are guaranteed to hold by the execution of S1.

THE GALACTIC BEACONS variable stars



The minimum aperture (x-axis) needed to observe a star of a given magnitude (y-axis) and the best magnification range (along the bars) are shown

OBSERVING variable stars can be great fun. It is one branch of stellar astronomy where an amateur can also do some useful work. Variable stars are those that change in brightness over periods ranging from a few hours to a year or more.

Variable stars can be divided into three distinct classes: regular, semiregular and irregular. The regular variables are of great importance to astronomers as some of them have greatly aided our understanding of the universe.

Further, variable stars fall into two groups: extrinsic and intrinsic. In the extrinsic type the variability arises from causes outside the body of the star. Algol and Beta Lyrae fall into this group. Intrinsic variables are those whose variability arises from the stars own instability. The Cepheid variables are representative of this group

Measuring brightness

The observation of variable stars is a matter of measuring in some way the apparent brightness of a star at some particular instant. Therefore for visual observation, one chooses stars with large variations in brightness and those within the telescope's aperture.

Under the most favourable conditions the normal human eye is just capable of glimpsing stars of magnitude 6.5. Whence it can be deduced that the magnitude m of the faintest star visible with a telescope with aperture D mm is

$m = 7.1 + 5 \log D$

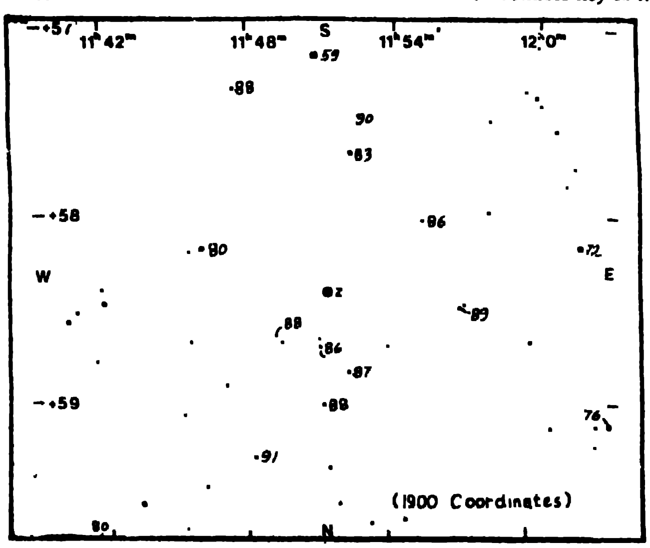
which agrees closely with the result arrived at by assuming that a 25 mm objective will show stars to the 9th magnitude.

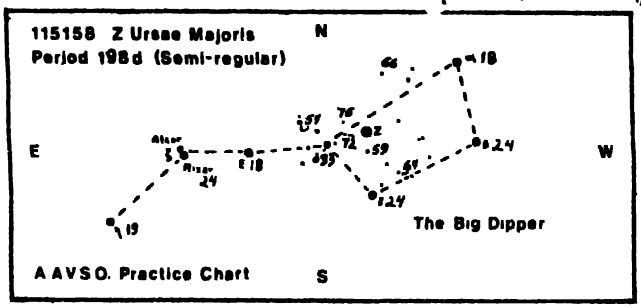
Apparent and absolute magnitude

Apparent or visual magnitude refers to the apparent brightness of a celestial body. The brighter the object the lower is its magnitude. The brilliant star Aldebaran in Taurus is of magnitude 1. The faintest stars normally visible to the naked eye (sharp) are of magnitude 6. The brightest stars have zero or, in a few cases negative magnitudes Sirius, the most brilliant star in the sky has a magnitude −1.4. On the other hand, the largest telescope can show stars as faint as +23 in magnitude. A star of the first magnitude is one hundred times as bright as a star of magnitude six. It is important to know that a star's apparent magnitude is not a reliable key to its luminosity. The pole star (mag. 2) seems nearly three times fainter than Sirius, but since it is much more remote from us it should be more luminous than Sirius

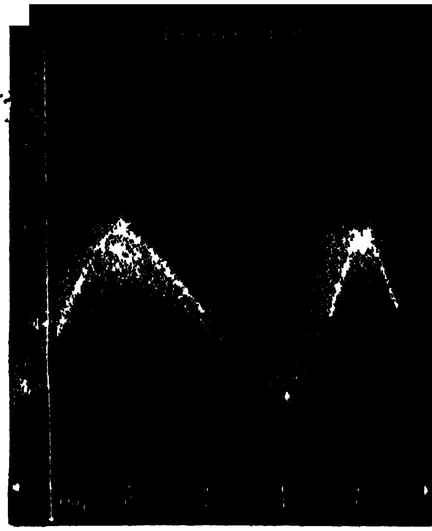
On the stellar scale, the brightest planet Venus has a magnitude of about −4.6. Full moon −12 and the Sun −27

Absolute magnitude is the apparent magnitude from a distance of 10 parsecs or 32.6 light years. At this distance Sirius would have a value of +1.3, whereas the pole star would be a brilliant object of magnitude −4.6. Absolute magnitude is, therefore, a measure of the star's real luminosity. The absolute magnitude of our Sun is +4.8, so that from a distance of 10 parsecs it would be a dim object.

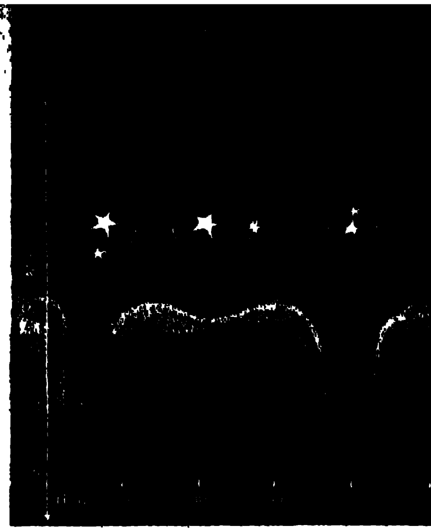




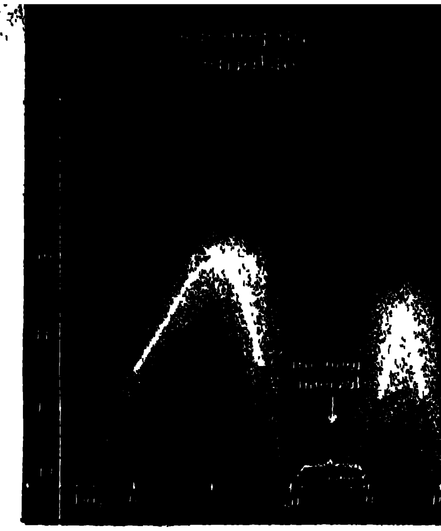
The northern circumpolar semiregular variable Z Ursae Majoris in the constellation Ursa Major (Saptarishi) is particularly well suited for the beginner (above). The chart alongside covering the close vicinity of the variable should be used for telescopic observation. The stars are represented as different size dots indicating their brightness. The numbers next to some stars are their magnitudes



Delta Cephei —a pulsating variable. As it swells and contracts its brightness varies



Algol—an eclipsing binary. Variations are due to a companion which eclipses the main star



A semiregular variable. Mira is such a star with a long period

Before you start observing the variable stars it is necessary to acquaint yourself with the sky and constellations. For this a good atlas is necessary (Nortan's star Atlas, Tirion's sky Atlas, American Association of Variable Star Observers Atlas are invaluable). Next an instrument for making the observations in the form of a telescope is needed. The most popular telescope used is a short focus (f/5 to f/8) Newtonian reflector with an aperture of 150 mm or more.

Delta Cephei

In our astronomy club at Nasik, a new and very active member asked me recently "If I were to start observing a variable star tomorrow night what do I begin with?"

"Delta Cephei" I said without hesitation.

Why did I choose Delta Cephei so quickly from the thousands of variable stars visible from here? This is an ideal star to start with for many good reasons.

First of all, the star should be easily located. Secondly, it should preferably be between fifth and seventh magnitude so that it can be observed with only a minimum of optical aid—a small aperture telescope or binocular. Delta Cephei which forms a lovely triangle with Zeta and Epsilon in the constellation Cepheus fulfils these requirements. For Zeta at visual 3.6 and Epsilon at 4.2 make ideal comparison stars for estimating its brightness. Delta Cephei belongs to a group of variables called Cepheid Variables. Its variation is regular and accurate over a period of several days. It enjoys a leisurely decline to minimum followed by a last minute rush to maximum brightness. Delta Cephei is so bright because it is much bigger than the Sun and hence more luminous. At its brightest Delta Cephei is easily visible at magnitude 3.6 and at its faintest it drops only to 4.3. It has a period of 5 days 9 hours and its regularity is precise to a fraction of a second. If you estimate its brightness every-day or two you will soon see how it seems to pulsate to the slow measured beat of a cosmic folk song.

Though the constellation Cepheus is not too easy to identify, at the North it can best be recognised by thinking of it as a little 'house' with a peaked roof. Delta Cephei lies near the bottom left corner of the 'house'.

A relationship between the luminosity and period of brightness variation of Cepheids was discovered by the Harvard astronomer Henrietta Leavitta in 1908. She found that the brightest Cepheids had the longest periods from her observations of these stars in the Small Magellanic Cloud, a nearby galaxy to our own.

Comparing the absolute magnitude of a Cepheid obtained from its period with the observed magnitude, its distance can be estimated. Measuring stellar distances is a trick y problem as the method of parallax can be used for the nearest stars. Farther out than about 200 light years the method becomes decidedly inaccurate and statistical techniques have to be applied. The period—luminosity law of Cepheid is thus a valuable tool for measuring not only the distance of the Cepheid itself but also of the star cluster or galaxy in which it may be situated. It is this property of these wonderful stars that prompted Henrietta to suggest that they can serve as galactic beacons for finding stellar distances.

So when you begin observing Delta Cephei you will be examining an important part of history as well and your observations will be a replay of the careful research done by Henrietta. The light curve of Delta Cephei (magnitude variation with time) is shown above. These variables display regular variations climbing sharply to a maximum and dropping off slowly with periods ranging from a day to several weeks. They are, in fact, *pulsating* stars—expanding and contracting, giving off most light before they are at their largest.

Some other variables

Mira (in Latin, the wonderful) in the constellation Cetus is also among the better known variables. Although it has been known to attain 3rd magnitude it can slip down to magnitude 9½ to become invisible to the naked eye for most of its period of fluctuation which is about 47 weeks. Mira is a red giant star. Antares is another red giant star to vary irregularly and it lies in Scorpius. Betelgeuse, the red giant in Orion, also behaves in a similar fashion but the variation is not so great.

Variable stars which have completely predictable periods are the *eclipsing binaries*. If two close stars revolve around each other, when one passes in front of the other the total amount of light coming our way will get reduced provided the plane of the orbit is suitably positioned. Algol (in Latin, eye of the demon) in Perseus is a fine example with a period of just under 3 days. There are also some eclipsing binaries in which one of the components is intrinsically variable.

Flare stars, novae and supernovae are known as *eruptive* variables. Flare stars are usually dim red dwarfs, which can sometimes brighten by several magnitudes in a matter of minutes. Our own Sun exhibits flares on a much smaller scale.

Novae are stars that blaze up suddenly, taking a few days or less to reach maximum brightness (tens of thousand times its original) and then slowly fade away into obscurity. Supernovae, which may brighten up by a factor of hundreds of millions are true celestial disasters, and are due to the almost complete disintegration of stars in awe-inspiring explosions. Some of them have even outshone their galaxies.

Sudhakar Bhalerao

Mr Bhalerao has been an active amateur astronomer of Nasik, for over two decades. He is among those who regularly scan the skies for comets

HARNESSING THE ENZYMES

S. F. D'Souza
G. B. Nadkarni

Do you know why papayas are added to meat when it is being cooked? It is certainly not to give flavour to meat. The enzyme, 'Papain' present in papaya has the property of tenderising meat and helps in its faster cooking. One may wonder what are these wonderful agents (enzymes) that are responsible for efficiently conducting complicated reactions under mild conditions of temperature and pressure. These are marvellous biological catalysts that sustain life on the Earth. They are responsible for controlling every chemical reaction that occurs within a living cell.

From antiquity, mankind has exploited the catalytic process of enzymes for different purposes. Way back in 7000 BC, Sumerians used yeast to convert sugar to alcohol and Egyptians used yeast to leaven bread. Ancient civilisation also made use of lactic acid bacteria for milk preservation. It was only in the beginning of this century that enzymes were shown to be responsible for all fermentation processes. Primitive man also recognised the effect of utilising plant and animal materials for food processing. First application of an extracellular enzyme probably occurred accidentally when milk was carried in bags made from goat stomach resulting in tastier solid food which we now call as cheese. It is known that cheese formation occurs due to renin, an enzyme present in the stomach lining. Also, animal faecal matter when applied to the flesh side of hide resulted in softening of leather (SCIENCE TODAY, February 1984). Hundreds of years passed before the active ingredients in excreta were identified as proteases (enzymes that break proteins) thus making it possible to substitute pancreatic or mold enzymes for bating of hides.

From these early beginnings in fermentation, cheese-making and curing of leather, enzyme application has spread to textile and paper industries, nutrition, foods, pharmaceuticals and medicine. Even though several thousands of different enzymes are produced by animals, plants and microorganisms, only a small percentage

Life depends on a complex network of chemical reactions that are taking place in a living system. Special chemicals called enzymes are responsible for these reactions. They are the catalysts of life and are found in every living cell, breaking big molecules into smaller ones.

Enzymes are protein molecules made up of chains of amino acids. They are very specific in their function. This means that a particular enzyme can control reactions involving only one particular kind of substance or group of closely related substances. The substance on which the enzyme acts is called its substrate.

The shape of an enzyme plays an important role in the specificity of an enzyme. Each enzyme has a three-dimensional shape having an area on its surface which takes part in the chemical reaction. This is the active site of an enzyme. The substrate also has similar shaped molecules that fit exactly into the active site. The substrate molecules fit into the enzyme molecules rather like a lock and key. No other key would fit that lock. When the enzyme and substrate are matched up, the chemical reaction proceeds to give rise to products and the enzyme is released. Many such reactions can occur within a minute's time.

In addition to a substrate many enzymes require other small molecular weight chemical compounds called coenzymes for their activity. A coenzyme may be an organic molecule, often a vitamin derivative, or a metal ion. It mostly participates directly in the catalytic reaction. The same coenzyme may be associated with many enzymes which catalyse different reactions. Many vitamins that we take in our diet, in fact, serve as important coenzymes in a living cell. Coenzymes, like enzymes, are continuously being regenerated in the cells.

Some chemicals are capable of stopping an enzyme working for a short time, some by getting in the way between enzyme and substrate molecules. This is rather like jamming the lock by inserting a wrong key into position. The right key can make the lock work only if the wrong key is taken away. These substances are known as inhibitors which are of great importance in the field of medicine.

S.F.D.
G.B.N.

Immobilised enzyme technique results in pure products with considerable cost savings

of enzymes has until recently been exploited and harnessed for commercial or industrial purposes. Unlike the conventional chemical catalysts that are used in industries, enzymes can operate with a high degree of efficiency and specificity under extremely mild conditions of pH (acidity), temperature and pressure thus obviating severe processing conditions and saving energy. However, until recently, industrial use of enzymes has been limited due to the high cost in obtaining them and their extreme instability on storage. Also, most commercial enzymes, being soluble are difficult to recover from the reactor effluents at the end of the catalytic process. This restricts the use of soluble enzymes to essentially batch-operations followed by disposal of these expensive enzyme – containing solutions. The feasibility and utility of enzymes could be greatly improved, if methods were developed for their easy recovery, reuse and improvement in their stability.

A possible approach to this problem is to attach enzymes onto a solid support material. Such an attachment immobilises or restricts the free movements of the enzyme molecules and renders them insoluble in aqueous media. An obvious advantage of the immobilised enzyme derivative is the ease with which it can be separated from reaction mixture, either by decantation or filtration. Thus, the catalyst can be used time and again resulting in considerable cost savings. Besides this, immobilised enzymes increase the purity of products. Over the past few years, research has advanced to the point where the technological potential of such immobilised enzymes is beginning to be realised. Currently, a new area of specialisation—enzyme engineering—has emerged, which deals with the study of production, isolation, purification, immobilisation and use of enzymes on the process scale in efficient reactor systems.

The first recorded use of an immobilised enzyme was by a Roman soldier who used a twig taken from a fig tree to stir and eventually curdle milk. It was not until 1951 that research in the field of immunology signalled the advent of covalently bound proteins. Since then a number of newer methods have been developed for immobilisation of enzymes.

Immobilisation techniques

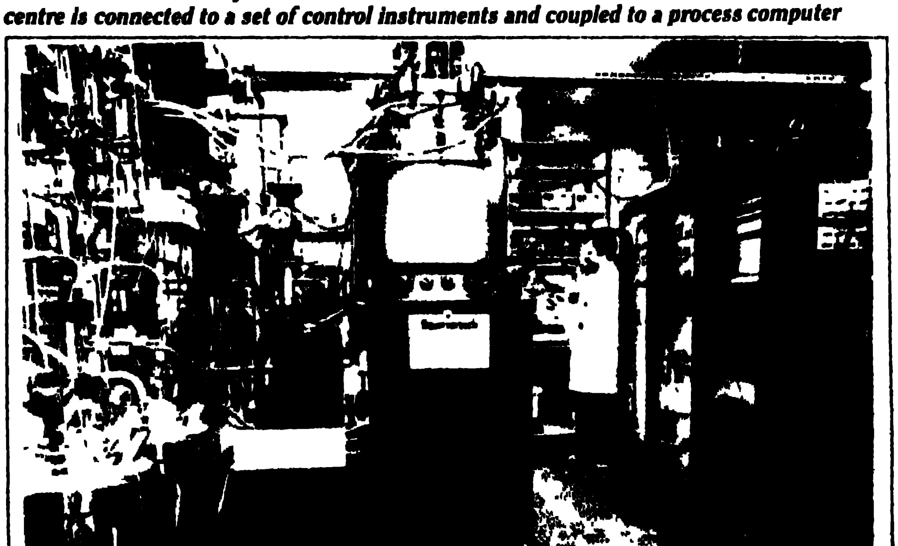
For the expression of activity by the immobilised enzyme it is necessary to retain the structural integrity of the enzyme without altering the amino acid residues at the site of catalysis. (see box on page 57). Five principle methods used for immobilising enzymes include adsorption, entrapment, encapsulation, covalent bonding and cross-linking (see Fig. on page 60). A combination of two or more of these methods may also be employed. No single immobilising system can be applicable to all enzymes in view of differences in the enzyme's composition, and overall charge distribution. The substrate characteristics may also influence the choice of the immobilising system.

Adsorption involves adhesion of a thin layer of enzyme molecules to solid supports. The solid support is provided by ion-exchangers like charcoal, silica-gel, glass beads, plastic-like resins etc. These are capable of exchanging ions bound to their surface for ions dispersed in the solution. The enzyme ions are taken up by the resin in place of its own ions, thereby forming a tight bond. Practically, the method is very simple. It consists of the enzyme solution being added to the solid support and stirred for a few minutes. The enzyme is adsorbed onto the support However, substrates of higher ionic strength can easily desorb the enzyme.

Entrapment of enzymes offers the advantage of relatively mild reaction conditions without significant alteration in the protein. It is carried out using polymeric gels. The procedure involves the addition of enzyme to a solution of small molecular weight substances (monomers). By altering the temperature or by addition of gel – inducing chemicals, the monomers link to form polymers resulting in gel. The enzyme gets trapped in the gel-matrix. The pore size of the gel-matrix is controlled so that it is large enough for the small molecular weight substrate to freely diffuse in but not large enough for the trapped enzyme to diffuse out.

Encapsulation is another method of immobilising enzymes. The enzymes in this method are enveloped in micro-capsules and in varied forms of membranes like nylon or collodion. These

Use of immobilised enzymes for treatment of industrial wastes. The fermentor in the centre is connected to a set of control instruments and coupled to a process computer



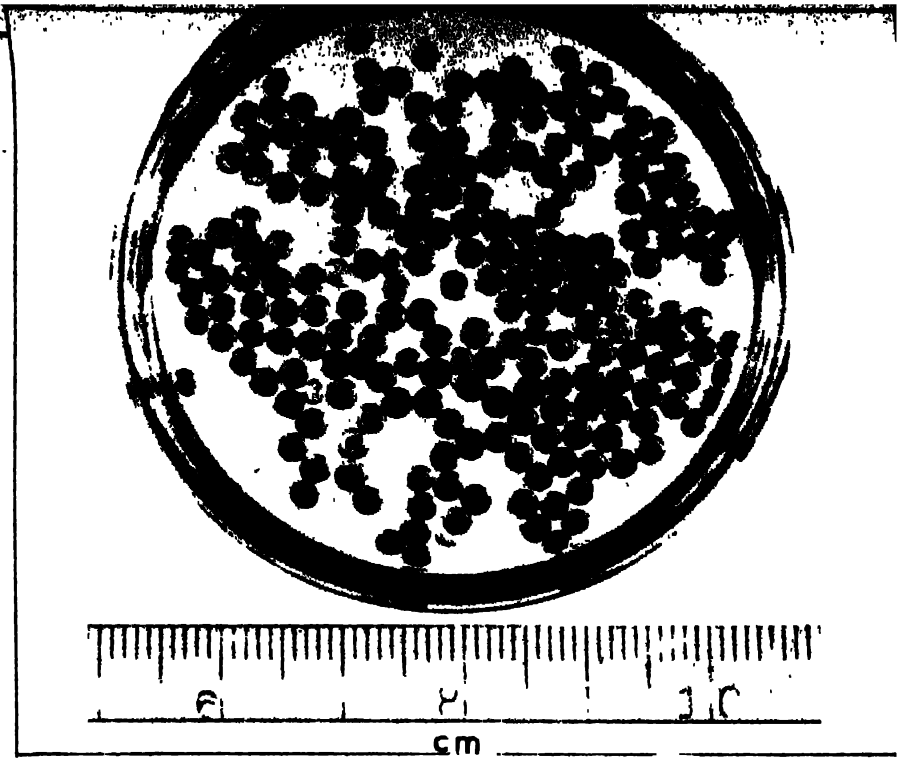
membranes are permeable to only low molecular weight chemicals and not to the enzymes and the macromolecules.

The choice of a matrix for binding enzymes depends on the nature of physicochemical properties of the enzyme and in its ultimate application.

Immobilisation of an enzyme can also be achieved by covalent bonding to a carrier through functional groups on the enzyme protein not essential for catalytic function. The covalent bonding of an enzyme is accomplished by a reaction with amino (N-) and carboxy (C-) terminal amino acids as well as reactive groups in the enzyme molecule like amino (-NH_2) group of lysine, carboxyl (-COOH) group of glutamic or aspartic acid, hydroxyphenyl groups of tyrosine, sulphydryl group of cysteine and hydroxyl group of serine. The attachment cannot be reversed easily by pH and ionic strength. However, it may alter the chemistry and reactivity of enzymes. In the extreme cases, the active site may be blocked through the chemical reaction involved in the attachment, thus rendering the enzyme inactive. But, various methods are available to protect the active site during attachment reactions.

Another method of immobilisation is to cross-link enzymes using bifunctional reagents. In this method, the enzyme molecule is made to aggregate. These aggregates grow in size, become insoluble in water and fall out of the aqueous solution. Cross-linking by itself may find little practical application because of the drawbacks encountered such as high concentration of enzyme required and formation of fine insoluble precipitates. However, a combination of adsorption followed by cross-linking may be more useful in immobilising enzymes.

Immobilisation of whole cells of micro-organisms is a better alternative to immobilisation of purified enzymes. This could obviate the necessity for extracting enzymes thus avoiding their inactivation during tedious and expensive enzyme–purification procedures. Also, enzymes are normally more stable when they are present in their natural state inside the cell than when they are isolated and purified. This may however, pose some limitations. Whole cells are impermeable to a number of substrates and products because of the diffusional barrier of the cell membrane. In such cases, cellular permeability needs to be enhanced by treatment with organic solvents like toluene or chloroform prior to their immobilisation. Unlike immobilised pure enzymes, immobilised whole cells will have a number of other undesirable enzymes which may lead to unwanted side reactions of both substrates and products thus decreasing the efficiency. Microbial cells, hence, need to be manipulated to reduce such enzymes that catalyse side reactions and induce high levels of the required enzyme prior to their immobilisation.



Hen egg white beads used as an insoluble support for immobilisation of enzymes and microbial cells

A large number of biochemical transformation may require immobilisation of not only a single enzyme system that catalyses one reaction, but also multienzyme systems that can carry out a complicated sequence of reactions. Thus, starch can be attached to glucose by the use of a single enzyme like glucoamylase. However, further conversion of glucose to alcohol requires many enzymes. Such multi-enzyme complexes can be tailor-made by binding different enzymes simultaneously on the same support. Alternatively, immobilisation of whole cells or cellular organelles permits immobilisation of multistep and co-operative enzyme systems. Therefore, immobilised yeast cells would have all the enzymes necessary for the conversion of glucose to alcohol.

Industrial applications

The greatest immediate potential of matrix-supported (immobilised) enzymes or whole cells lies in the food industry, pharmaceutical industry and in the waste treatment. One of the first processes scaled up to an industrial level was immobilised penicillin acylase for the production of semi-synthetic penicillins. More than 50 per cent of the 6-amino penicillanic acid is currently produced enzymatically using the immobilised system. In the USA, about 1,300 tons of immobilised glucose isomerase is used annually for production of about 3,000,000 tons of high fructose syrup. A number of immobilised enzymes and microbial cells are employed in the preparation of L-malic acid, L-aspartic acid, urocanic acid and resolution of DL-amino acids in Japan.

Hydrolysis of the residual proteins in beer (chill proofing of beer), which otherwise precipitate and give a cloudy appearance on storage, can be carried out by immobilised proteases. The immobilised enzyme process prevents the contamination of the final

Biological catalysts are now being exploited in an economically attractive fashion

product. Similarly, pectinase has found use in the clarification of fruit juices. Residual glucose in several food products can be removed by bound glucose oxidase to eliminate unwanted colouring reaction and taste alterations. Glucose oxidase can also be used to produce gluconic acid which has many applications in food, pharmaceutical and detergent industries. The modification of steroids by immobilised multi-enzyme system and whole cells is also being extensively investigated specially in the synthesis of cortisol and prednisolone. Lactose — hydrolysed milk obtained using immobilised lactase would help a large number of people who cannot digest milk because of the deficiency of this enzyme in the intestine. Also, lactose-hydrolysed milk has found number of applications in dairy industry specially in the preparation of soft ice-creams. In the waste treatment, immobilised microbial cells can be used in the denitrification of water. Immobilised amylase is made use of, in the treatment of waste waters from paper manufacturing units that contain colloidal starch and in the removal of phenols by phenol oxidase.

Analytical applications

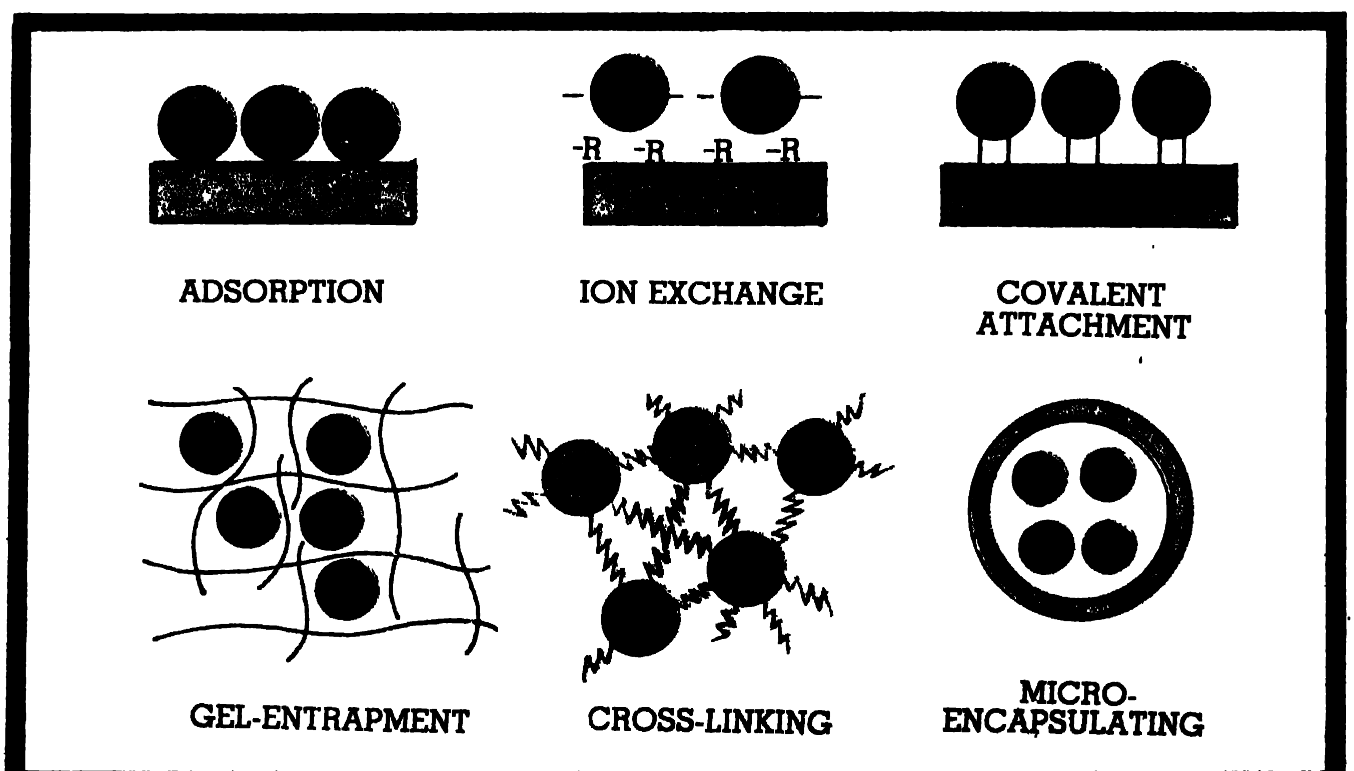
The immobilised enzyme technology has given rise to innovation in new analytical techniques, especially in the field of electrochemical sensors (ion selective electrodes) and highly automated enzymatic methods of analysis. Urea is detected by an ammonium ion (NH_4) electrode coated with urease. Similarly, glucose oxidase immobilised on oxygen electrode is used in direct and quick determination of glucose in blood and other fluids. A large number of such systems are available for the determination of cholesterol, amino acids, ethanol, asparagine, cyanide, methanol, etc.

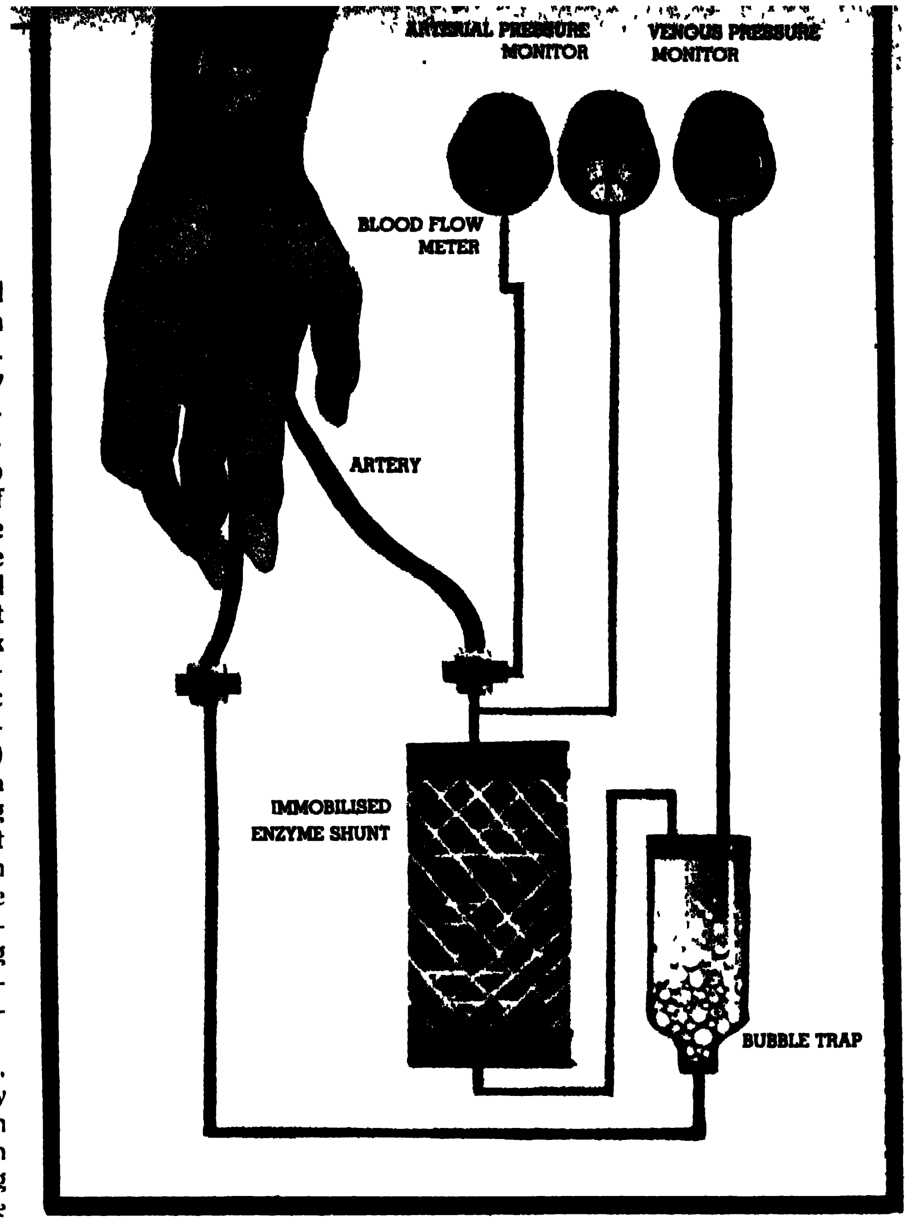
A new class of enzyme sensors called enzyme thermistors or thermal enzyme probes have recently been developed. It has become possible to measure heat associated with the reaction of an immobilised enzyme by using thermistor. Automated analytical systems called "Enzymax" have been developed by coupling enzymes to the inside of the sample transfer tubes for continuous monitoring of products. Determination of pollutants or other toxic compounds using immobilised enzymes has also been possible. Thus, immobilised cholinesterase has found use in the detection of enzyme inhibitors from both air and water. Metal ions can also be detected using immobilised enzymes. A new technique called the volatile enzyme product method (VEP) based on mass spectrometry and immobilised enzymes, has been developed for estimating any biochemical material involved in the enzyme catalysed reaction having a volatile product or substrate.

Medical applications

Many diseases, particularly inborn errors of metabolism are as a result of deficiency of certain enzymes. Direct administration of enzymes may lead to immunological reactions like hypersen-

Different techniques of immobilising enzymes





Extracorporeal shunt system

sitivity, rejection, rapid removal and inactivation by the antibodies which are formed against these enzymes. However, the drawbacks can be easily overcome using immobilised enzymes.

The feasible way to immobilise enzymes for clinical therapy would be to entrap enzymes in a microcapsule of red blood cells or liposomes or to the inner surface–polymeric tubes like nylon. In cases where encapsulated enzymes come in contact with blood, it may be desirable to complex them with heparin to prevent coagulation without the need of systematic heparinisation. It has also been possible to immobilise heparinase (enzyme) on Sephadex beads. In cases where a patient is kept on a heart-lung machine, heparin is added to prevent clotting. However, heparin remains in blood even after it is returned to the body. Due to the anti-clotting properties of heparin, internal bleeding occurs. In order to prevent this, immobilised heparinase can be used to remove excess of heparin in blood.

To carry out therapeutic action, enzymes need to be located specifically in certain tissues, organs or even in selected intracellular sites. Such targeting could be achieved by using artificial cells. By either varying the surface characteristics or by co-entrapment of some magnetic material, it could be possible for enzymes to be taken up by specific cells. If the substrate to be acted upon is in the blood, the immobilised enzyme can be more conveniently used in an extracorporeal system (see Fig.). Since the immobilised enzyme does not enter the body, it has become an obvious candidate for early applications in patients.

Based on these techniques, studies are being carried out to see the feasibility of replacing hereditary enzymes. Asparginase has been found to be useful in the treatment of certain types of cancers. L-asparagine which is essential for the growth of tumour cells but not for the normal cells, is broken down by this system. The use of an extracorporeal shunt system as well as subcutaneous implantation with immobilised L-asparaginase has proved to be more efficient than the direct administration of the enzyme. The immobilised enzymes could also be used for the construction of artificial kidneys, pancreas, liver detoxifiers and biochemical fuel cells as a power source for cardiac pacemakers. For artificial kidney, microcapsules containing urease are packed in a column and connected to the patient's blood stream. Ammonia produced by the action of urease can be removed by charcoal or ion-exchange resins, also encapsulated and packed in the column. Such a device is expected to modify bulky and costly dialysers currently in use.

There are interesting possibilities within the field of immobilised biocatalysts which will need concerted interdisciplinary exercises involving chemists, biochemists, microbiologists, medical scientists, chemical engineers, and industrial processors to achieve the final goal. With the advent of other biotechnological disciplines like genetic engineering and tissue culture, it is sure that in the near future many existing enzyme applications will be replaced by immobilised systems and many new sytems will become commercially feasible. □

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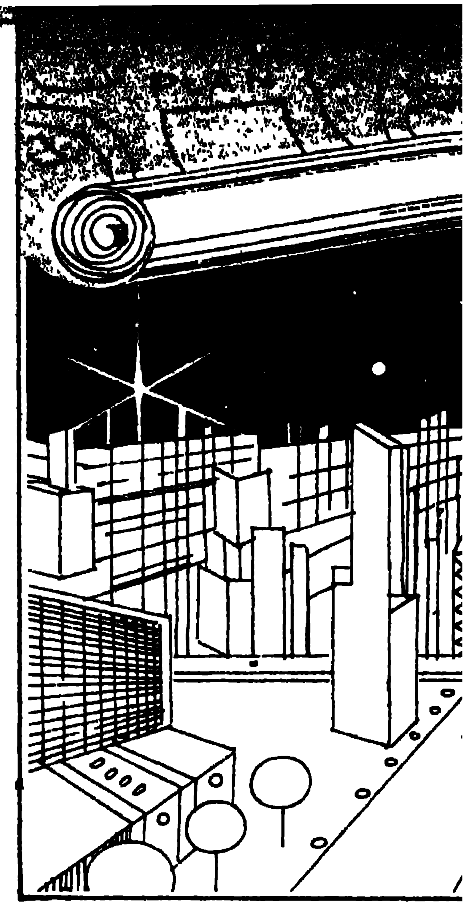
Dr Nadkarni heads the Biochemistry and Food Technology Division, Bhabha Atomic Research Centre (BARC), Bombay, and has carried out research in Enzymology for over 25 years.

SCIENCE CITY—to be or not to be?



The proposed Science City, continues to draw scientists into a heated discussion. Surprisingly, however, neither the promoters of the proposed Science City nor the Government, has in any way responded; not even to make available details of the aims, objectives or plans of this venture. In response to Prof. Udgaonkar's viewpoints and our editorial calling for a debate (SCIENCE TODAY, March 1984, pages 9 and 16), quite a few of our readers have expressed their views. This response has been encouraging, though one would have expected it to be more enthusiastic. The silence, particularly of our senior scientists, policy makers and the scientists' association is inexplicable and disturbing. It is possible that everyone is waiting for specific details and perhaps even these will not be forthcoming unless and until a strong public opinion is generated. Here we are publishing a few letters and will continue with the debate in the ensuing issues.

THE Science City that the Government of India proposes to set up at a cost of Rs.125 crores to attract Indian scientists working abroad, calls for careful planning and debate. The debate need not be acrimonious or polarise Indian scientists into camps of 'those for' and 'those against'. The idea in itself is a laudable one and the motivations, from wherever they come, must also be in the best interests of promotion of science and technology in India. Yet the debate that the Editor of SCIENCE TODAY is seeking to launch, must take place. I am not sure if a 'public debate' will be of any help. But the views of more and more committed scientists, of the standing of Prof. Udgaonkar must be sought. The counsel of Indian scientists working in India should not go unheeded.

'Science culture', 'scientific temper' and 'science-mindedness' are fashionable words today. So, statements on India, Indian scientists and our scientific culture, such as those by Dr. A. N. Malviya in *Nature*, can at best be viewed for what they are: ponderous statements. They fall in line with the series of articles Mr. Khushwant Singh, then the Editor of *The Illustrated Weekly of India* had published in his magazine. He had queried 'Are we the laziest people?' 'Are we the most jealous?' and so on *ad nauseam*. Nirad Chaudhari had called India a thousand names she did not deserve. V. S. Naipaul did his vehement bit. The worst was a series of articles that appeared in the West German magazine *Der Spiegel* on India. The title devastatingly called India, 'the sick giant of Asia' (*der kranke Riese Asiens*). What these writers did and continue to do unto the culture and civilisation of India is now being done by some Indian scientists settled in India and abroad unto Indian science. This is scientific masochism.

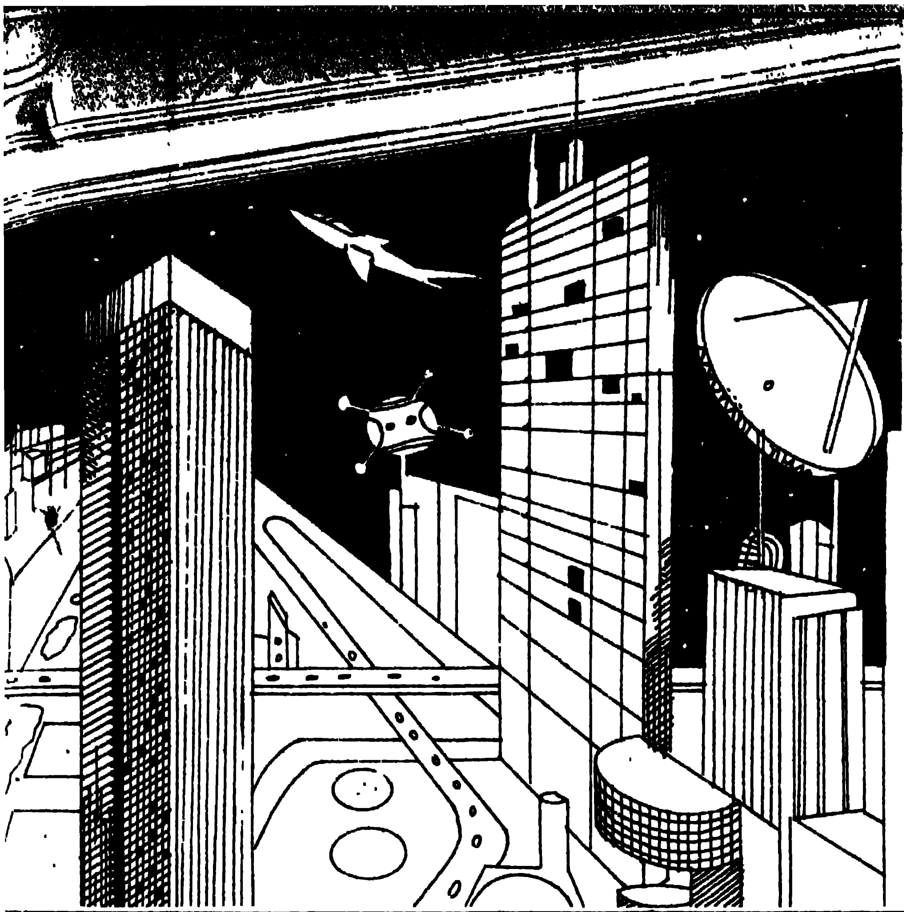
I had somewhat strayed. I had myself stayed long enough 'abroad' to see that there is only a difference in degree and not in kind between the Indian scientist (that grumbles over India in India) and the one who does it from abroad. Inasmuch people like Dr. A. N. Malviya are not 'typical'. Therefore, the debate is also not expected to ensue between Indian scientists abroad and Indian scientists in India.

Prof. Udgaonkar has put his finger on the precise point that needs to be debated: will Indian scientists working in India have the same privileges as are sought to be given, under the Science City scheme, to Indian scientists working abroad? If the answer is no and the latter are given preferential treatment, then the Government of India will be unwillingly creating **two** classes of scientists. That would be the 'most unkindest cut of all'.

On the other hand may be the Government of India might create only two 'categories' of scientists and not two 'classes'. For class will be inherent, Science City or no Science City. Homi Bhabha's ringing words about the 'test of an outstanding scientist', which Prof. Udgaonkar had reproduced, say it all. The City may be in the Nilgiris or in the plains. But the scientists working there can rise only as far as it is in them to rise. Commitment to the cause of science in India and personal and intense involvement alone can produce results in the Indian environment. A salubrious locale, well-equipped laboratories, and munificent funding by a Government alone cannot produce good science nor technology.

What we could do though is to create more centres of excellence in science; recognise excellence which, after all, must reside in the individual scientist, be he in India or abroad, and support his science. This latter asnect, which is being recognised by the Department of Science and Technology of the Government of India, is the very basis of the spectacular progress which German science made through the establishment of the Max-Planck Society (initially Kaiser Wilhelm Gesellschaft). The central philosophy of the Society was to identify individual scientists of promise—unmistakable promise—and support them. Fortunately excellence, in science as in any other avocation, stands out.

My own stand in the matter of the planned 'Science City' or 'Technology City' would be: (1) The details have to be spelt out clearly before plunging headlong. (2) There is need for debate,



ILLUSTRATED BY FRANCIS H. D'SA

informed debate and this debate must take into consideration the views of Indian scientists. (3) If any one knew how to make the mare of Indian science go, then it must perforce be the leaders of Indian science working it out in the Indian context. Those of them who were seminal in creating the 'atmosphere' for scientific work in India must be a party to this expensive and well intended move. (4) Just as Caesar's wife must be beyond suspicion, an undertaking so lofty in conception and so noble in intention must be able to stand public scrutinity. (5) Any 'Science City' put together in haste can only be a township housing scientists who will relate to one another only in their alienness and little else.

Bhabha was apparently fond of a line from a verse by a Latin American poet: 'Traveller, there are no paths. Paths are made by walking'. In wanting to lay the paths, the Government of India, in its anxiety to excel, must not create an asphalt jungle where no intellectual/scientific blade of grass can grow.

M. K. Chandrashekaran

Prof. Chandrashekaran heads the Unit of Neurobiology & Mechanisms of Behaviour, at the Madurai Kamaraj University, Madurai.

SINCE 1947, the Central Government has invested a considerable amount of money in setting up a chain of National Laboratories, Regional Research Laboratories and IITs. And, we have not yet been able to contribute sufficiently to the development of indigenous technologies and industries so far.

The very proposal of the new Science/Technology City also emphasises the same point. If we wanted to utilise the services and experience of the highly qualified and trained Indian scientists abroad, there were alternative ways of doing so. A large number of such persons with appropriate knowledge and experience could have been selected through the various Indian embassies and placed within the existing set-up to develop new units based on their experience and, at the same time, appropriate for the development of new high technology industries within the country. Even now, there is enough opportunity to plan and work in this direction by introducing a more flexible system (allowing them more freedom for realisation of their concepts) in order to enable them to settle down happily.

Finally, regarding capable manpower, the late Dr. Homi Bhabha, in his presidential address to the then National Institute of Sciences of India (now INSA) in 1963, pointed out the depleting effect of the National Laboratories on our universities in his remarks: "... It was then assumed, naively, the posts in the chart could be filled by advertisement, forgetting that workers of appropriate and high level either do not exist in India, or can only be obtained at the sacrifice of some other institution, which thus becomes weaker for it. Our universities weak as they always were, have been further weakened in this manner".

So, instead of proliferating new laboratories/institutions should we not strengthen our existing National Laboratories, IITs and the universities by placing the same foreign trained people in different sectors? In addition, we should try to effect better coordination between the industries on the one hand, and the abovementioned laboratories/institutions on the other.

S. K. Guha

Prof. Guha is Manager, Photometry, Peico Electronics & Electricals Ltd, Phillips India, Calcutta.

I entirely agree with the viewpoint expressed by Prof. Udgaonkar in your March 1984 issue. The concept of a 'Science City' to be manned by expatriate scientists is short-sighted and counterproductive in the long run. It is an affront to our scientists.

There are two factors which promote such ideas: a mixed attitude of 'servility' and 'glamour about anything western', and selfish motives on the part of expatriate scientists and their promoters here. The concept of a Science City is very much against our desire for self-reliance and a blow to our national pride. Not only does it demoralise the scientists who are working here, but also there is every likelihood of third rate migrants flooding the Science City and wasting our resources. There is a remote possibility of some of these acting as spies also! Our scientists and their organisations should protest against this.

K. R. Prasad

Dr. Prasad works at Tirupati, Andhra Pradesh.

"VIJAY!" Mother stood at the door. "Do you know how late it is?"
"Oh, Mummy!" pleaded Vijay, clutching the book tightly.
"No! not a word! It's half-past ten, already." Mother came into the room and took the book from his hands. He made a last, vain attempt to get it back and then submitted, albeit sulkily.

THE MARTIAN CHITAR

Narayan Dharap

"It's so exciting!" he whined.

"Well, you have the whole of tomorrow to enjoy it," she said firmly and marched out of the room, clicking off the light as she passed the doorway.

For a moment Vijay felt angry, but his eyes, heavy with sleep, were already closing...

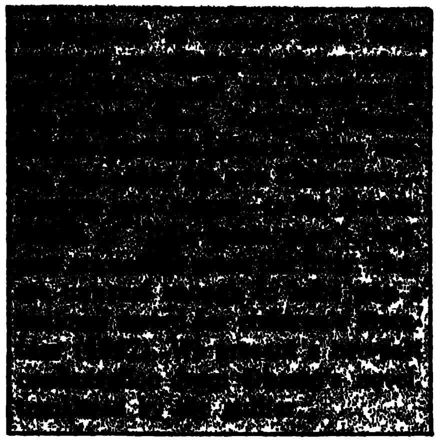
And in his dreams they were all there! Superman and Luke Skywalker, Flash Gordon and Magnus Robot fighter... Heroes indeed! With glorious abandon they galloped across star-spangled galaxies, swooped through the air, drove like the very devil... these men with iron fists and nerves of steel... such indeed is the stuff of dreams...

Mother had reason to worry about Vijay who was barely thirteen and in the ninth standard. But lately he seemed to have turned into a prodigious bibliophile. Not that he neglected his studies or games; but he read in all his spare moments. He was a sensitive dreamy child, ready to embark upon a vivid trip into the world of fantasy at the slightest encouragement.... describing with relish the heroic feats and dastardly villainies of his dream-figures. Vijay's fanciful yarns worried his mother. Words! Words! she thought; does he know the meaning of even one! But Father, professor of sociology in the small town college, seemed quite unperturbed. Boys will be boys, he said.

But she forgot these thoughts when she watched Vijay playing for hours on blazing Sunday afternoons or sitting with his ears glued to the radio listening to the cricket commentary... Maybe his father is right after all! She felt her son would soon outgrow these boyish fantasies...

By the time the school show got over by eight o'clock, it had become quite dark. The streets were deserted. Vijay left his friends at the bus-stop and started for home. Now that Mother was not with him, he could take his favourite short-cut. Near the third lamppost after the stop, a side fence had come down; Vijay jumped across the thorny hedge, climbed over a couple of stone stiles and struck across an empty plot.

The plot had always been vacant as far back as Vijay could remember. The colony had conveniently turned it into a strolling-green for the grown-ups and a play-ground for the kids; on summer evening, the place was a veritable *mela;* but this winter night, the dark grounds were deserted, bungalows huddled round the grassy oval bathed in starlight, the buildings seemed remote and



withdrawn but for their windows, faint, frosted squares of light.

Vijay glanced up. The moonless night sky was blazoned with stars which glittered and twinkled like diamond dust across the velvety black. For a moment he even forgot the cold, so glorious was the sight. He remembered something about Jupiter and Mars... one a faint yellow and the other an angry red... Vijay didn't know their positions, or even whether they would be up there at all; but he kept on looking up, all the same.

And suddenly he saw the two points of light. One yellow, the other red; both twinkling and moving. For a moment, he was confused. Stars should be colourless and planets shouldn't twinkle... and neither of them should move thus... because these two points of lights were moving, faster and ever faster, approaching, swooping down towards him..

Only then did he become aware of the sound. It was as if someone had turned the radio full volume. All the instruments in the world seemed to have joined in... the wailing strings, the sighing flutes, the beats of the bass drum... For a moment he remembered an English movie he had seen with his father.... but no! This was no discordant cacophony. .. this sound, which filled the dark winter night, and wrenched at his very soul, was the sweetest thing he had ever heard...

Then he forgot the sound. The twinkling lights were very nearly upon him; and he saw they were no ordinary lights: it was more of a glow; an aura with softer colours showing now and then.... The lights came on, without a sound, without a whisper and settled down, as radiant and iridescent as a soap-bubble...

Vijay's heart was hammering with excitement... five paces from him was a strange, glittering object from the heavens. It looked like a plastic cage, but he could not be sure. He had to shield his eyes against the coruscating emerald greens, golden yellows, pure reds, sunset oranges, and deep violets

The sound died away; the night became still; but for a curious moment Vijay felt the sound within his body; all atoms vibrating and straining to a curious rhythm...

Vijay was in a quandary; he didn't know whether to stand or run. Then he just stood where he was.

VIJAY!

He started at the sudden call. He swung around to look for the caller.... He was alone; he and this strange machine from the stars!

VIJAY!

The call was repeated; though the syllables were clear, yet there was something lacking, it was like the compulsive tick-tock of a clock, a whisper of the breeze... but oh! how clear! how crystal clear!

Suddenly Vijay felt utterly lonely and lost. He became afraid.

VIJAY! DON'T BE AFRAID! THERE'S NO REASON TO BE SO SCARED! TAKE A HOLD ON YOURSELF, VIJAY!

The sounds rushed at him from all sides, from the stars, from the trees, even through the ground ..

"Who is it! I don't see anybody!" After a considerable lapse of time, Vijay found enough courage to whisper into the dark night.

WE ARE YOUR FRIENDS VIJAY!

"Oh, but who are you! Where are you speaking from!"

YES! YES! WE'RE COMING TO THAT! BUT WOULD YOU MAKE A PROMISE NOT TO BE SCARED!

Vijay said nothing. He just stood and stared.

VIJAY, TELL US ONE THING. DOES OUR VOICE SCARE YOU? THE TRUTH, VIJAY!

And now that Vijay thought about it... No! He felt no fear at the voice, indeed it felt like a dear, jolly friend . a real friend... no; he felt no fear in him

"No, No! I won't run away! Tell me!"

VIJAY WE COME FROM MARS! WE ARE MARTIANS!

Martians! Vijay gasped. But recently he had learnt that Mars was a lifeless planet... and if they were indeed Martians, why should they come to a small town like this? They could easily go to some big city like London, New York, Moscow or at least Bombay . No! No! somebody was playing a joke on him .

VIJAY! THIS IS NO JOKE! THIS IS THE ABSOLUTE TRUTH!

"Oh, but how can it be! Mars has no air, no water..."

DON'T WE LIVE THERE?

"But how can you prove that you are from Mars?"

OH! WE'RE GOING ROUND IN CIRCLES, ISN'T IT?

"And why should you come here? Supposing that you are from Mars, that is?"

ONE THING AT A TIME, VIJAY! WE'D SOON PROVE TO YOU THAT WE'RE INDEED FROM MARS! WOULD YOU LISTEN TO US TILL THEN?

"But why did you come to me?"

IT'S A BIT COMPLICATED, VIJAY - IF YOU HAVE SOME PATIENCE YOU'LL UNDERSTAND EVERY THING—SO LISTEN TO US - WE LIVE ON MARS IN FACT HAVE BEEN DOING SO FOR THE LAST MILLION YEARS OR SO - WHATEVER YOUR BOOKS MAY SAY! AND THIS MACHINE—WHAT DO YOU CALL YOUR MACHINES THAT GO TRAVELLING IN SPACE?

"Spaceships," Vijay said promptly.

AND A CLUMSY WORD, TOO! WE CALL OURS CHITAR - SO OUR CHITAR HAD BEEN RETURNING FROM A DEEP SPACE VOYAGE WE HAD GONE FAR IN THE SPACE BEYOND OUR SOLAR SYSTEM - AND WHILE WE WERE PASSING BY YOUR EARTH, WE HAD TROUBLE IN OUR MAIN ENGINES THE CHITAR LOST ALL VELOCITY AND STOOD STILL IN SPACE — WE CANNOT PROCEED UNLESS WE REPAIR THE DAMAGE AND THAT'S WHY WE ARE HERE

Vijay heard this fantastic story in spellbound silence. For the moment he believed all that was told to him. And he had the most curious feeling that a man/creature with a voice like that cannot lie.

"Oh! But how can I help you? You should gone to teacher or better still, a College Professor ... is it not?"

The voice sounded sad as it answered Vijay. INDEED THAT'S JUST WHAT WE TRIED FIRST .. BUT, BUT SOMEHOW IT WOULDN'T WORK—

"But why? They should know all about machines!"

NOT THAT, VIJAY! THEY DON'T BELIEVE US!

"What do you mean?" Vijay was at a loss.

VIJAY, NOW PAY CLOSE ATTENTION TO US HOW ARE WE CONVERSING WITH YOU? WE ARE NOT SPELLING OUT WORDS BY MOUTH SYLLABLE BY SYLLABLE AS YOU DO WE ARE TALKING MIND TO MIND - WE CREATE THE THOUGHTS IN YOUR BRAIN AND MIND DO YOU KNOW WHAT THIS IS?

"No." Vijay sounded wistful

WELL IT DOESN'T MATTER REALLY BUT DO YOU KNOW WHY WE CAN TALK WITH YOU? BECAUSE YOU BELIEVE IN US!

This was totally beyond Vijay In fact his first idea had been that somebody was playing tricks on him. Believing and not believing he felt that somehow he was missing the point

VIJAY, WE CAN READ YOUR THOUGHTS NOW THIS IS A BIT DIFFICULT, BUT PLEASE TRY TO UNDERSTAND MAY BE YOU DON'T BELIEVE THAT WE HAVE REALLY COME FROM MARS BUT IN YOUR HEART OF HEARTS YOU BELIEVE THAT THERE IS LIFE ON MARS. DON'T YOU, NOW?

"Oh, yes! yes!" Vijay said, remembering his dreams.

THAT'S IT! IT IS ONLY THOSE WHO BELIEVE IN US WHO CAN COMMUNICATE WITH US THUS – AND YOU ARE ONE OF THEM, VIJAY!

"But what do you want? What possible help can I give?"

WE WANT CERTAIN THINGS — WHERE CAN WE GET THEM? THERE MUST BE SUCH PLACES WHERE YOU GET THINGS--

This talk of "things" and "places" was altogether too vague for Vijay; but he thought over it for some time -- places where you get things — of course! They were enquiring about shops!

"Oh, yes, we have such places! But they

must have closed down long ago -- it is too late now..."

THEN WE WON'T GET ANY THING NOW?

"No--you will have to wait.."

HOW..?

They must have used a word for "time", Vijay thought. "A long time till the sun comes up - may be twelve hours -"

This talk of time reminded Vijay how late the hour was. He was already late He had to go. Mother and Father must already be sick with worry and anxiety They seemed to read his thoughts.

VIJAY WILL YOU COME HERE WHEN THESE SHOPS OPEN?

"But I haven't even seen you! How shall I know you?"

THAT'S TRUE AND WE ARE A BIT STRANGE LOOKING

All of a sudden, a picture rose before Vijay's mind's eye It was an artist's imaginary sketch of Martians a creature about three feet high, with spindly arms and legs, a face like a ripe pumpkin, two filament-like antennae sprouting in place of the ears

NO! NO! The voice came hurriedly WE AREN'T LIKE THAT

"Then how am I to know you?"

WELL I CAN APPEAR LIKE A MAN FOR A SHORT WHILE AT LEAST -- CALL ME BY MY NAME

"And what's your name?"

GOGRAM! came the voice. AND MY PARTNER'S NAME IS GOGRAN! IS EVERYTHING CLEAR NOW?

"And you will be here? Promise?"

VIJAY, WE NEVER BREAK OUR WORD

"Then I shall be here in the morning."

YES - DON'T FORGET, VIJAY...

Before the words died out, the strange music started again. The shining machine shifted and raised itself off the ground. For a breathless second, it floated like an iridescent sphere of glass, and then it slowly rose; up and up; the lights merged into one another; fainter and fainter; and finally it was merely one of the millions of celestial lights.

Something wrenched at his very soul; he felt a sob coming up, he blinked once and then rushed home through the suddenly empty cold deserted night

Vijay was perfectly right in assuming that Father and Mother would be worried When he reached home, mother was standing at the gate, uneasily looking up and down the street. She saw Vijay from a long way off and came to meet him hurriedly

"Vijay! Where have you been all this time?" her face was almost comic in its relief "We were so worried"

For a moment Vijay didn't know what to say.

"Your father has twice been to your school, Vijay," she said. "He found the boys gone and the school locked. It is now half past ten! I am of a mind Oh! here comes your father!"

Father came up the street, furiously pushing a bicycle. He saw Vijay, heaved a great sigh of relief and carried the cycle inside Generally, he was never angry with Vijay, but tonight Vijay was scared stiff. He came in the house, but didn't let go Mother's hand Father had seated himself in a deep armchair and was wiping the perspiration off his face. Vijay stood before him, his head hung down.

"Come on! Out with it!" Father was restraining himself with an obvious effort. "Where have you been, Vijay?"

Vijay said nothing.

"How many times have I told you to return home at the proper hour? Nights are dark, streets deserted, so many thugs and rogues are on the prowl ... haven't you sense enough to know that we might be worrying about you?"

"Yes, Father," Vijay mumbled.

"Then tell me where you've been all this time!"

Vijay's tongue stuck at the words. Suddenly he knew that they would never believe him!

"Come on! Out with it!" Father's voice was rising.

Vijay stood silent, uneasy and miserable.

"Vijay, for the last time, tell me the truth! If you've committed any mistake, confess it—but tell me the truth—otherwise...."

"Oh Vijay!" Mother said, "Tell him! Don't be so adamant!"

Vijay felt the futility of it all. Even if he told the truth they wouldn't believe a word of it; and if he kept silent...that won't help matters either...And through no fault of his...his eyes began to smart, and a big, shining tear welled out of his eye.

"Oh! This is the limit!" Shouted father. "I haven't even touched you yet... but I see that I'll have to, shortly."

Choking and stumbling, Vijay blurted out everything. But to his own ears the story sounded contrived and impossible. But what could he do?

"Lights? Music? Martians? Ha! Vijay! You think I'm a fool? Tell me the truth...."

Poor Vijay stared back in hot-faced confusion.

The result was inevitable: five strokes on his palm No dinner. Vijay was locked up in his room.

His hand hurt like the devil. But the humiliation was even more painful. Sobbing and snivelling, Vijay was tossing about on the bed when Mother tiptoed in.

"Asleep, Vijay?" She whispered. Vijay was angry with her; he didn't say a word. Mother came in and sat by him, gently stroking the boy's hair and tearful face.

"Vijay, here's a glass of milk," she said

Vijay had left house at half past three for the school show. He was awfully hungry-...but he hid his head under his arm and said nothing.

"Oh darling! Oh Vijay, you've had nothing to eat since morning. Do take this milk, for my sake, baby..."

Vijay clenched his mouth shut, but he couldn't keep the sob back. His mother kept on stroking his hair.

"Oh, hush, honey! Don't cry so! Why didn't you tell your father the truth, dear?"

And what had he done, then? Sobs wracked his small body and tears came in floods. Mother silently picked him up and held him to her breast. When the fury of his emotions had subsided somewhat, she again held the glass of milk to him. He gulped it down and snuggled close to his mother. He never knew when he fell asleep and when mother left him.

Vijay snapped out of his sleep with the first lilting strain of the strange music. The music! The dark room was throbbing with the bewitching strains.

VIJAY! The call of Gogram!

"Don't speak a word to me!" Vijay spat out in the darkness.

OH VIJAY! WE KNOW WHAT HAS HAPPENED! AND BELIEVE ME, WE ARE VERY VERY SORRY FOR IT! BUT NOW YOU KNOW WHY WE COULDN'T GO TO ANYBODY ELSE BUT YOU! THIS IS THE PRICE OF DISBELIEF!

In spite of his anger, he was already listening attentively.

VIJAY, WE CAN'T COMMUNICATE WITH ANYONE ELSE! WE KNOW THAT YOU'VE SUFFERED A LOT TODAY ON OUR ACCOUNT BUT VIJAY, YOU HAVE TO BE FAITHFUL TO SOMETHING IN LIFE, ISN'T IT! WHATEVER OTHERS MIGHT SAY OR DO!

Vijay didn't understand all of it, but somehow, he felt that it was true and proper He kept on listening silently.

SO WILL YOU COME TOMORROW! WE NEED YOUR HELP!

"And suppose I don't come?" he whispered in the dark room.

WHY! WE'LL HAVE TO SEARCH FOR SOMEBODY ELSE!

"You won't be angry with me?" He said in sudden surprise.

ANGRY! WHAT'S THAT GOT TO DO WITH IT! IF YOU DON'T WISH–

"Oh no! I'll come! I'll come!" Vijay almost shouted.

THAT'S THE SPIRIT! AND REMEMBER THE NAME—GOGRAM!

The music dissolved in the darkness.

And Vijay was fast and peacefully asleep.

Sunday morning was cold but pleasant Vijay generally had the whole day to himself and started it by getting up late. Today he got up even later than usual because of his disturbed night. In his half-wakeful state, something was tugging at his mind. Then suddenly he remembered everything... everything... and he jumped out of bed.

He had to meet Gogram at nine o'clock!

But enthusiasm drained out of him even before he reached the door of his room. Nobody at home believes me, he thought. He went dragging his feet. He had eaten nothing the previous night and he was ravenously hungry. Mother knew it (as she knew all things!) and without a word kept his breakfast beside his cup of cocoa, and until he had cleaned his plate, she didn't utter a single word.

When Vijay flung a towel on his shoulder and started for the bathroom humming a tune, she was pleasantly shocked! Usually he had to be almost pushed in the bathroom. Today he was ready in ten minutes.

"Mother, can I go out for a while?" he asked.

"Vijay, I want to talk to you," Mother said.

Vijay knew what she wanted to talk about and he started to wriggle uneasily.

"Vijay, what happened yesterday night?"

"Oh, Mother, I swear by you that what I told Father yesterday was the truth—every single word of it! Oh, I love you two so much—why should I lie to you, tell me!"

She stared into his wide innocent eyes for a long time. She was visibly confused. Finally she sighed and said:

"Oh, I don't know. You've to convince your father, Vijay..."

"Mother, can I go out? Please?"

Vijay, lunch is at Twelve. Will you be back by then?"

"Oh, yes, Mother. Promise! Can I?"

"Oh, all right..."

Vijay was out of the house in a flash. Mother could hear whoop fade away in the morning air.

It was cold outside and Vijay missed his pullover; but the thought of the meeting with Gogram filled him with excitement, driving out all thoughts of cold and bodily discomfort

Gogram! What a name! And they—whoever they might be—had told him to remember the name—as if anybody'd forget it!

Vijay crossed the road and entered the vacant plot. The mango and neems along the border were burnished with gold in the morning light. Gone was last night's desolation the ground was full of children ...playing, screaming throughly alive...

Vijay stood on the edge for a moment, trying to reconstruct last night's dramatic events. Where was he when the glittering machine from the sky swept down on him? He couldn't be sure, but he felt he must have been somewhere near the central mount which was nothing but a gentle swell in the plot. At the moment this natural platform was empty, but obviously *that* was the place where to expect Gogram, if he ever came at all.

He had hardly taken five steps when all of a sudden the sunlit morning was vibrating to the curious, unnamable tune. Vijay knew that this was no earthly music; but the sense of its swelling from the air was so strong that he turned around. When he looked at the mount again, he almost froze in his tracks.

There was the figure of a tall man on the mount. How and from where he could have come? Were his eyes deceiving him? Vijay stood and pondered; and all the while the music (if music it was!) was gathering strength, surging through his mind and body.

OH VIJAY! COME ON! came the familiar call.

For the first time Vijay was afraid. He remembered Father's admonition about thugs and rougues.

VIJAY! IT IS I! HAVEN'T I EXPLAINED EVERYTHING TO YOU YESTERDAY! OH, COME!

There was such a rush of camaraderie, in the voice. Vijay mastered his feelings and manfully approached the solitary figure on the mount. The figure was tall, with a widebrimmed hat pulled well down and concealing the face, a scarf swathed round the lower part of the face, a heavy overcoat with its collar turned up, the coat reaching well below the knees, and below that again, black trousers and shoes. His hands seemed to be thrust deep in the coat pockets.

Vijay came near and stopped again. He was aware of the large, shining eyes, looking at him from the dark shadow of the hat. He stood there for a moment, but had to avert his eyes...all of a sudden he had felt a sort of queasiness deep down inside him.

OH VIJAY! WHAT ARE YOU AFRAID OF?

Without looking up at the strange eyes, Vijay reached the mount.

VIJAY, YOU ARE SCARED, ISN'T IT!

Words were impossible; Vijay simply nodded his head.

BUT WHY! DON'T YOU BELIEVE ME?

When pinned down like this, Vijay had to admit—at least to himself—yes, he believed him. Gogram was his friend.

"How did you come so suddenly? and why couldn't I see you yesterday night?" Vijay stammered out.

OH, THAT'S IT, IS IT! VIJAY, CAN YOU HOLD IT FOR A MOMENT! I'LL TELL YOU EVERYTHING— BUT NOW WE'VE VERY IMPORTANT WORK BEFORE US—WE'VE TO GO TO YOUR SHOPS—SHALL WE GO!

"But what exactly do you want?" Vijay asked rather doubtfully. "If I know that, I'll take you to the proper place straightaway."

The man who called himself Gogram took his hand from the pocket and held it before Vijay. Three cubes nestled on his

ILLUSTRATIONS BY NANA SHIVALKAR

palm. One was glass-like, colourless and transparant: the other was a shining white like nickel or chromium; and the third a dull yellow. They sparkled in the morning sun.

TAKE THEM, VIJAY, KEEP THEM WITH YOU WE'D PREFER THIS GLASS-LIKE MATERIAL FAILING THAT, THIS WHITE ONE AND IF THAT ALSO ISN'T AVAILABLE WE'LL SETTLE FOR THE THIRD

Vijay took the three cubes. And Gogram put his hand in his pocket. A glove had covered it right upto the tips of the fingers... but Vijay felt that there was something strange about the hand. Something unnatural. He couldn't figure it out the first time. The hand was just an ordinary hand, the palm also, the fingers. .

There were no fingers! The glove had covered everything, but he had seen! The hand didn't end in five ordinary digits... it ended into a broad stump.. as if..as if.. .

VIJAY! DIDN'T I TELL YOU YESTERDAY THAT WE'RE DIFFERENT! JUST FORGET IT FOR THE PRESENT. WILL YOU COME ON!

Somehow Vijay got his mind under control.

"Gogram, suppose this thing is available—how much of it do you want! A pound? A kilo? A maund?"

I DON'T KNOW THESE WORDS—COME LET'S GO--LET'S FIND IT FIRST- THEN I'LL TELL YOU—

Vijay put the cubes in his pocket and turned about, the main market of the town his destination.

With long, smooth strides, tall Gogram easily kept pace.

It was half-past-eleven when they returned to the plain. Vijay's little legs were aching after the long and fruitless walk, fruitless, because Gogram's search had failed. Vijay had taken him to practically all the shops in the town—first the big ones on the main streets and then the small, obscure shops tucked away in small lanes and alleys; so much trouble and no success!

First Vijay had taken Gogram to the hardware market. But the moment he stopped in front of a shop, came Gogram's voice:

NO! VIJAY, WE WON'T GET IT HERE! TRY THE NEXT—

After this had happened half a dozen times, Vijay said with some surprise "But how can you tell without even going in?"

Gogram's reply had a hint of suppressed laughter in it.

VIJAY, I CARRY A MACHINE—A METER. THAT'S WHY

Then Vijay had tried the electrical goods market When the first shop came, there was the hint of a hope for the first time in Gogram's voice.

VIJAY! LET'S GO IN HERE! THIS SEEMS MORE LIKE IT

Without a thought Vijay stepped in. Behind the counter, a middle-aged man was busy with a machine. He left his work and approached them and addressed himself to Gogram.

"Yes? What is it?" he asked. Gogram said nothing and the salesman repeated his question, a bit more loudly, this time.

VIJAY, ASK HIM THIS QUESTION ASK HIM IF THEY REPAIR INDUCTION MOTORS-- MIND YOU—INDUCTION MOTORS

Vijay knew he was going to make a mess of it, but he said it none the less. Stumbling on every word he stammered out.

"Do you—Do you repair induction—ah—induction motor?"

"Keep out of this, Kid! Let your father speak!" said the salesman.

VIJAY, WE WON'T GET IT HERE! LETS GET OUT!

Both of them turned to go. The salesman spluttered in a rage, "What's this nonsense? Wasting people's time? Here! Don't run away like that! I want to know something about you two! This town is infested with pranksters and shoplifters like you . "

He raised the counter flap and started to come out Vijay was about to swoon with fright. But there was the voice of Gogram—

DON'T WORRY, VIJAY! I'LL ATTEND TO THIS! LET'S GO!

There was a sharp click! from the repair bench. A motor started. There seemed to be no load on it. The purr turned into a whine and then into a screech as the revs picked up. The salesman stood indecisively where he was for a moment and then barged into the shop, muttering angrily to himself.

Gogram stopped in front of a radio shop.

VIJAY! LET'S SEE HERE! MAY BE WE'LL GET IT HERE!

This time Vijay was very cautious indeed as he stepped in.

IF THEY ASK YOU, TELL THEM WE'RE JUST LOOKING.

As soon as they entered, the expected question came.

"Yes? Come in, please. What can I do for you?"

"Nothing, Thank you! We are just looking," Vijay said boldly.

The salesman evidently disapproved people on sight-seeing tours, but beyond keeping a close eye on them, he said nothing.

Gogram, with Vijay following, was wandering through the counters and showcases. Radios, Record changers, Taperecorders of all varieties were displayed along with many spare parts. Gogram didn't spend much time, but his glance seemed to take everything in.

NO! VIJAY, THERE'S NOTHING HERE FOR US!

"You understand all this, Gogram?" Vijay asked

WELL, MOST OF IT AT ANY RATE THERE ARE SOME NEW THINGS, BUT VIJAY, YOU ARE ON A WRONG TRACK

"What wrong track?" Vijay didn't understand a word.

OH, NOTHING, VIJAY COME ON!

The attendant was watching them. He seemed quicker and sturdier than the electrical repairsman If he had any suspicion—

DO NOT WORRY, VIJAY! COME ON!

So they stepped out; radioshops and general merchants, Jewellers and goldsmiths, toy shops and watch companies—nothing seemed to satisfy Gogram COME ON VIJAY! he kept on saying.

Vijay slumped down on a rock. The sun was scorchingly hot and Vijay felt as if he hadn't eaten for day. He took out the three cubes from his pocket and held them out to Gogram

"Take these, Gogram And now what?"

OH KEEP THEM WITH YOU VIJAY! LET ME THINK A BIT

Vijay kept staring down at the shining cubes in his hand

"Gogram, suppose you get this thing—whatever it is—how much of it would you be wanting?"

WELL, IT WILL BE ABOUT THE SIZE OF YOUR HEAD

"And your white machine broke down for just that one piece?"

OH VIJAY, YOU STILL DON'T BELIEVE ME! VIJAY, OUR MACHINE IS SOMETHING FAR DIFFERENT THAN WHAT YOU THINK

And at that moment Vijay remembered Professor Shiv Shankar He was their neighbour and if anybody knew about these strange shining cubes of Gogram, it had to be he! Gogram had suddenly become still as he followed Vijay's thoughts.

YES, VIJAY SHOW HIM THESE THINGS! BUT CAREFUL.

"Why? He has known me since I was a toddler—"

YES BUT THESE THINGS ARE NEW TO HIM! HE'S SURE TO ASK YOU WHERE YOU GOT THEM—TELL HIM YOU FOUND THEM WHILE PLAYING ON THIS GROUND

Vijay stood up. He had to be home before twelve. Relations between Vijay and his father were a bit strained, just now.

VIJAY, I KNOW WHAT HAPPENED YESTERDAY NIGHT—AND WE BOTH ARE VERY VERY SORRY FOR IT—YOU WERE CERTAINLY NOT AT FAULT

"Gogram, I have to run away now...."

WHEN WILL YOU COME AGAIN, VIJAY!

"But what can I do now? I tried all the places I know."

WELL, THERE'S STILL TIME—WHEN WILL YOU COME?

"How about today evening, say six o'clock?"

YES—FINE—AND REMEMBER ABOUT THE CUBES

Professor Shivshankar, or Nana, as he was known, was in his late fifties. He and Tai, his wife, occupied the large bungalow next door to Vijay. They had no children and showered all their affection on Vijay. And Vijay being a normal child, responded with equal ardour.

This Sunday afternoon as he barged in on the Shivshankars he found Nana in his study, going through the weeklies.

"Are you very busy, Nana?"

Nana folded the paper and removed his glasses.

"Yes? What's it, Vijay?"

"Nana, see what I found on the ground!" Vijay held out his palm, he had been gripping the cubes very hard and they were sweaty by now. Nana gave them a cursory glance and turned to his paper.

"Well, very fine! What do you want?"

"Nana, can you tell me what these things are?"

"All right, let's see them." Nana straightened up in his chair, put on his glasses and picked up the cubs, humming quietly to himself. All of a sudden he stopped humming and sat up bolt upright and still.

"Where'd you find this, Vijay?"

"On the colony grounds "

"When?"

"Yesterday."

"But where on the grounds exactly?"

"You know the small mound in the middle? Just by the side. ."

"There was nothing else? No marks? No box? Packing case?"

"No. One of these shining cubes caught my eye."

"Shall I keep them with me for a day or two? I'll take them to the laboratory with me tomorrow and have a check up on them—O.K.?"

"Oh, that's quite all right, Nana. Will you be able to tell me something about them tomorrow evening?"

"Oh, you, I think so ... I think I am sure of it."

Vijay left the house still as excited as ever.

...He remembered a couple of occasions when Gogram had reached out to him, either to advise or to comfort him. Suppose *he* called out to Gogram now, for a change?

Well, he could make a try at least. He shaped his mouth and gave out a silent call in the darkness.

"Gogram! Gogram!"

There followed a couple of minutes of tense silence. Vijay was on the point of repeating the call ... when suddenly the music sprng up around him—Gogram was there!

VIJAY! IT'S I, GOGRAM!

For the first time, Vijay felt that Gogram's voice was even more strange and more attractive than the music.

ARE YOU BUSY JUST NOW GOGRAM?

WELL, YES! AS A MATTER OF FACT, I AM! WHY!

"Is it very important work?"

WELL, IT DEPENDS—WHY?

"Gogram, I couldn't come to you this evening. But I've given your cubes to the professor ... I told you about him?"

PROFESSOR OF WHAT? VIJAY!

"Oh, I don't know that! But he—Nana--said that he was going to take the pieces with him to his laboratory—"

LABORATORY? OH I SEE

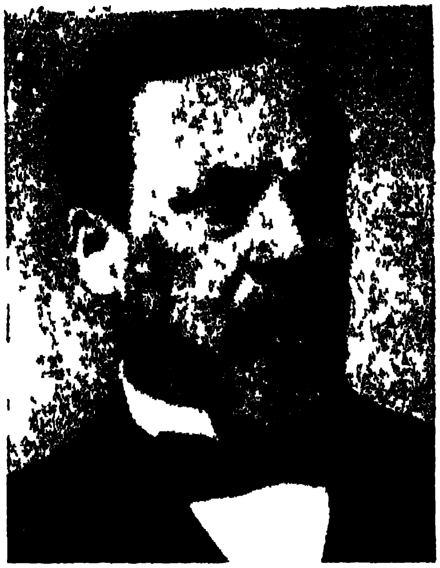
"Gogram, he seemed very surprised on seeing the cubes."

VIJAY WHEN HE REALLY EXAMINES THEM, HE'S GOING TO BE A VERY SURPRISED MAN INDEED!

"Gogram, suppose you don't get these things here—then you would be stranded here for all time?"

Did Gogram save his Martian chitar? What happened to Vijay? Read about their adventures in the next instalment

1. Pasteurise—B Some foods and beverages subjected to this heat-treatment method can be rid of harmful germs Named after French scientist Louis Pasteur (1822-1895), who showed first that wine and beer could be prevented from spoilage by heating to about 57°C for a short while Milk can be pasteurised by heating at 62°C for 30 minutes, but the time can be shortened if the temperature is raised Today some foods are even subjected to beta or gamma rays, a process called radiation pasteurisation

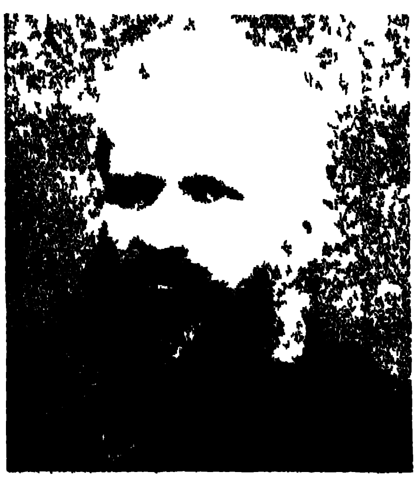


4. Wattage—A: A watt is equal to 1/746 horse-power, or one joule of work done per second. (In electricity, it's the power dissipated when a current of one ampere is carried between points having a potential difference of one volt.) Named after James Watt, the Scottish engineer who lived between 1736 and 1819 and invented the steam engine, among other things.

Watt's aunt reproves him for wasting time. Inset Watt in middle age

2. Galvanise:—A Although in ordinary parlance the word means "to stimulate", galvanisation involves coating iron or steel with zinc to protect it from rust and corrosion About 35 per cent of the world's zinc is consumed this way The term derives from the name of Italian scientist Luigi Galvini (1737-1798), whose pioneering studies actually consisted of "stimulation" using bio-electricity Although Galvini made great contributions to the theory of electricity, his basic training was in medicine—he took an MD and specialised in anatomy and obstetrics

3. Angstrom—A A unit of length equal to 10^{-10} metre, and named after Swedish physicist Jonas Anders Angstorm (1814 1874) One of the founders of spectroscopy Angstorm's studies were far reaching—from the composition of the Sun's atmosphere to zodiacal lights and thermal conductivity



5. Fallopian tubes—A These connect the ovaries to the uterus, providing for the movement of the male sperm to the female egg Named after Italian surgeon Gabriel Fallopius (1523-1562) who made pioneering studies of the genital organs Fallopius discovered and explained the functions not only of these tubes, but several important nerves, even the canals of the ear It was he who also named the vagina clitoris, placenta, cochlea, palate, etc (all names with Greek or Latin origins, as you can see)

6. Magellanic—C: The Magellanic Cloud is a galaxy named after the 16th century navigator Ferdinand Magellan. Actually this is considered to be a twin companion galactic system to our Galaxy. The Magellanic twin galaxies are some 150,000 light-years from us. But if that's too far for you, at home too we have the Magellan Straits, between the tip of South America and Tierra del Fuego, named after the great adventurer

7. Vulcanise—B: Vulcanisation is a chemical finishing process to improve the tensile strength, elasticity and other physical properties of rubber, both natural and synthetic. The first to vulcanise rubber was Charles Goodyear (1800-1860), an American In 1839, he dropped some India rubber mixed with sulphur on to a hot stove by accident and discovered the process Goodyear eventually got a patent, yet had to face so many legal problems that others made millions from his discovery. But when Goodyear died he left his family heavily in debt

Thank you Mr. Goodyear!

8. Daltonism—C: A form of colour blindness where green and red are confused. So named because the English scientist John Dalton (1766-1844) suffered from it.

9. Braille—B: System of writing that uses raised dots, and can be read by touch Named after the blind Frenchman Louis Braille (1809-1852), who worked out the system and published treatises on it Despite his blindness, Louis also proved to be a talented musician, and even devised an adapted version of braille for representing musical notations.

10. Celsius scale—A: Also called the centigrade scale, it is the most widely used temperature scale today. It has zero degrees for the freezing point, and 100 degrees for the boiling point, of water Swedish astronomer Anders Celsius (1701-1744) invented the thermometer having this scale

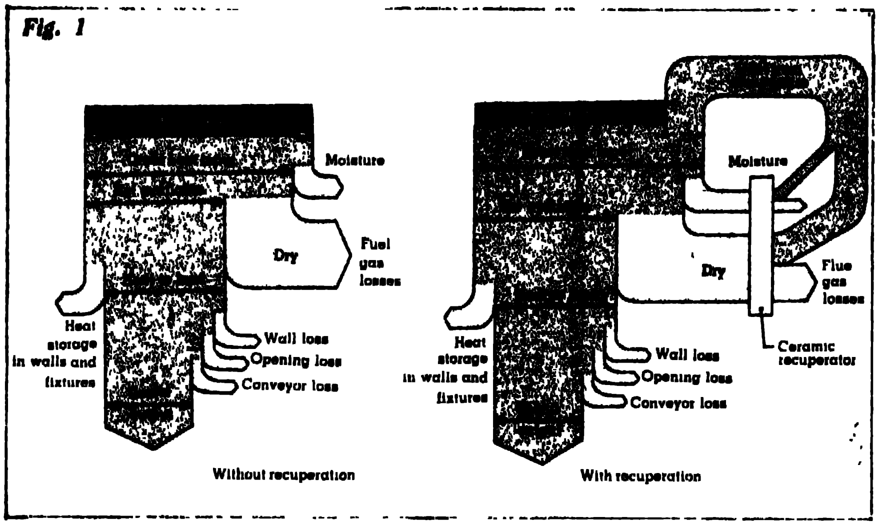
WIN A PRIZE!

Send us a list of other scientific terms that originate from the names of people. The longest list of correct terms we receive on or before 5 August, 1984 wins the prize—a full year's free subscription to SCIENCE TODAY. But.... as with all good things— there's a small hitch: you must first identify the 'odd man out' among the ten terms here, *giving us the reason.*

EVERYBODY seems to have been foxed by our quiz on processes (March [illegible]). Although we did get long lists of processes—without explanations—no one sent in the odd man out, which was *grating*. Grating is a pun really. It [illegible] a process as well as a thing, a piece of glass with parallel grooves used to separate white light into different colours. Still, as a consolation we have [illegible] the prize to the longest list—from K. Mohan of Rourkela.

FUEL-SAVING CERAMIC RECUPERATOR

Fig. 1



FURNACES in metal rolling, heat treating and forging industries waste enormous quantities of high grade heat. A furnace operating at a temperature of 1400°C and venting the exhaust gases directly into the stack, loses about 68 per cent of the energy input. Fig. 1 illustrates the energy input, output and heat losses for a typical furnace.

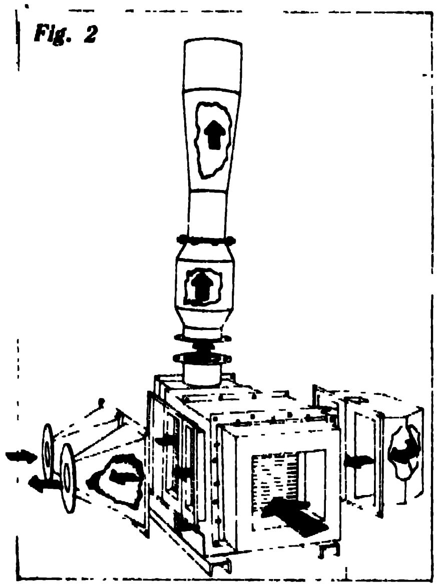
Metallic recuperators have been used for preheating combustion air by heat recovered from exhaust gases with resultant savings in fuel input. However, they suffer from severe technical limitations. High temperature creep, oxidation and corrosion caused by vanadium and sulphur in fuel, restrict their use to about 900°C. In high temperature applications, therefore, dilution of the exhaust gases is essential resulting in a reduction of air preheat temperature and net fuel savings.

Another limiting factor in furnace waste heat recuperation is the inability of available combustion equipment to take in combustion air at high preheat temperatures. However certain refractory materials used in the the ceramic recuperator helps to handle exhaust gases upto 1400°C. It can be easily installed and saves fuel up to 50 per cent.

A ceramic cuboid with a honeycomb of air and gas passages at right angles to each other forms the core of the recuperator (see *Fig. 2*). These passages allow for cross flow heat exchange between the hot flue gases and the combustion air.

The ceramic material used provides for high thermal shock resistance, low thermal expansion and good corrosion resistance. The channel widths have been optimised for

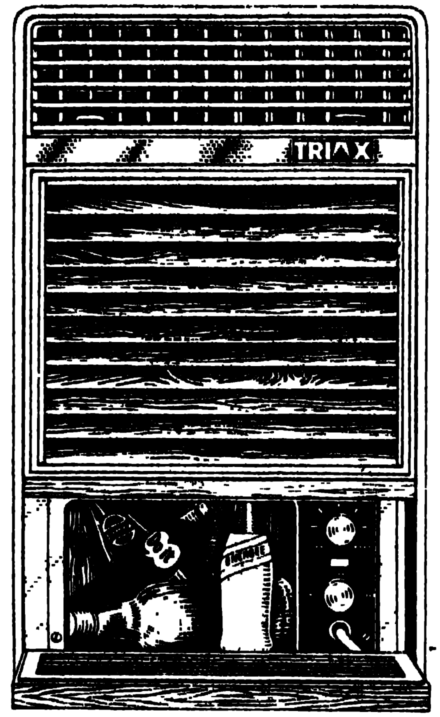
Fig. 2



minimum pressure drop and maximum heat transfer.

The cuboid is placed in a sealed and insulated metallic housing. The complete module thus consists of the ceramic core, the resilient refractory seal and the insulated housing.

Some of salient features of the ceramic recuperator are the high fuel savings from 30 per cent to 50 per cent depending on furnace operating temperatures. It has a high temperature resistance, ensuring safety of operation with a wide temperature range upto 1400°C. The recuperator has a longer life because of high corrosion resistance. It is compact, easy to install because of its large surface area per unit volume. It does not involve change in existing burners.



Airconditioner-cum-bottle cooler

COOLNESS is what everyone desires in summer. To cater to this need, a firm in Bombay has manufactured a new vertical window airconditioner with a built-in dehumidifier-cum-bottle cooler.

The airconditioner cabinet is 38.5 cm wide and 66 cm in height and can therefore fit comfortably into most single window openings without any alterations. There are separate doors in front of the grill providing easy access to the bottle cooler compartment as well as to the evaporator coil filter.

The filter can easily be removed and cleaned periodically without removing the entire grill. Constant supply of fresh air is provided through tiny ducts. The fan motor is permanently lubricated and therefore no periodic oiling is required.

The entire unit is mounted on a sturdy steel frame enabling the air conditioner to be firmly supported at the corners and sides. This helps to reduce vibration and noise.

The teak-wood grill is coated with multiple layers of melamine to make it waterproof and scratch and stain-resistant.

We use dry cells in torches, radios, toys, watches and electronic gadgets. Of all the primary power sources—a primary power source is an electrochemical system which cannot be recharged; the rechargeable system is called a secondary system, for example, lead/acid battery—the zinc/manganese dioxide cell (popularly known as zinc/carbon) is the most common; it consists of a zinc anode, manganese dioxide cathode, and an ammonium chloride electrolyte. A carbon rod provides electrical contact to the manganese dioxide cathode. Although, by and large these cells give a satisfactory performance for general consumer applications, they have certain disadvantages for military applications. They tend to be too heavy for portable equipment and have a poor shelf life. Further,

[illegible]

Eye-in-the-sky made sharper

THE imaging capabilities of "eye-in-the-sky" satellites employed for weather forecasting and numerous other applications could be markedly improved as a result of a discovery in the US of a practical way to make use ultrasensitive indium antimonide in the infrared detectors used in these systems.

The breakthrough will mean that indium antimonide—the most sensitive and lowest-cost material available for this type of detector—can for the first time be employed in space satellites. Until now the material has been limited to imaging systems aboard aircraft or on land because of extreme cooling requirements.

For maximum effectiveness, infrared detectors employing conventional indium antimonide must be operated at temperatures below 149°C, which can be maintained only by cooling them with liquid nitrogen or liquid helium. These coolants evaporate and must be replenished or replaced periodically, ruling them out for unattended space satellites.

An indium antimonide wafer is given a special, high sensitive coating by dipping it in a supercooled melt consisting of indium, antimony and trace amounts of a desirable impurity or dopant

By contrast, the new ultrasensitive indium antimonide material will permit the detectors to perform effectively at temperatures as high as −116°C. These temperatures can be maintained indefinitely by satellite refrigeration systems powered by on-board solar cells.

Infrared imaging systems are based on the principle that all forms of matter give off some heat. The heat is emitted as infrared light waves, which are invisible to the human eye. These light waves (located beyond the red end of the spectrum) can be detected by heat-sensitive materials and recorded to make a "picture" of the object.

Most aerial infrared imaging systems employ a rotating mirror to reflect radiation from ground-level objects onto a detection surface consisting of an array of pencil-point-size sensors. The sensors convert heat energy from the objects into proportional electrical signals, which are processed by computer into data or video images.

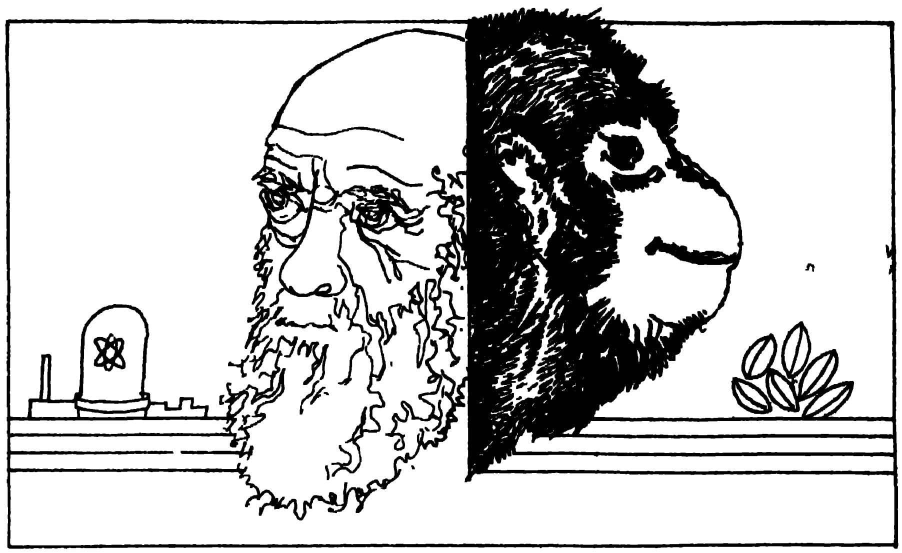
When infrared radiation hits one of a detector's sensing sites, a charge proportional to the amount of absorbed heat is generated. A conducting plate located at one side stores the charge for a fraction of a second until it can be "read" by electronic scanning circuits.

To perform effectively, detectors must be able to retain a charge in their "potential wells" until scanning occurs. Conventional infrared detectors are plagued by a noise phenomenon (called "dark current") comparable to static. This disturbance degrades the accuracy of the infrared radiation readings and, thus, the quality of the images.

It was determined that certain types of impurities in the indium antimonide play an important role in the generation of this dark current. This was reduced markedly by developing a special process that controls the amount and type of impurities.

In the new process, a conventional indium antimonide wafer is coated with a thin, high-purity overlayer. The costing layer is precipitated onto the wafer from a supercooled melt consisting of indium, antimony, and a special impurity, or dopant. Great care is taken to "boil off" all undesirable impurities from the mixture. Like the original wafer, the coated wafer has a mirror-like finish. This allows it to be fabricated into detectors employing conventional processing techniques.

Darwin and the ape within



THERE is nothing more dangerous than a good idea that falls into the wrong hands. Poor old Darwin merely observed that we shared our distant ancestors with the great apes, and the next thing you know people like Konrad Lorenz are writing rubbish about "man as he is today, in his hand the atomic bomb, the product of his intelligence, in his heart the aggression drive inherited from his anthropoid ancestors".

More than by Freud, even more than by Marx, the ideas that rule our century have their source in the man who died a hundred years ago today: Charles Darwin. His theory of evolution is the foundation of our present view of mankind's origins and our relationship with the natural world. However, it has also been grossly misused to purvey other, quite unproven assumptions.

Despite the recently renewed attacks upon it by some fundamentalist religious sects, Darwin's theory of evolution continues to command almost universal assent amongst educated and open-minded people. It is just a theory, of course, but then so is the law of gravity. (Nevertheless, until someone observes objects falling upwards, people will be reluctant to jump off cliffs.)

Recent allegations that some biologists are coming to doubt Darwin's theory are quite misleading (and often deliberately so). His key observation that all living things are related to each other by descent, like the members of a single vast family tree, is not challenged by any serious scientist.

It is only his particular theory of natural selection, his attempt to explain how species came to be so widely varied (which he worked out before there was adequate scientific knowledge of genetics or mutation), that has been questioned by some modern biologists

Sadly, Darwin himself is not free of blame for the non-scientific and misleading way in which his theory has been converted into a sort of alternative creation myth, with the Christian doctrine of original sin smuggled back in Indeed, he encouraged his cousin Francis Galton to pursue the ideas which in one form were to lead through 'social Darwinism' to new justifications for racism, and in another, even more harmful form to the concept of the 'beast within us'.

It was Galton who theorised that the "civilised races of mankind" (and above all the English, of course) had evolved to a higher level than "savages", an idea eagerly seized upon by racists in every succeeding generation. It was also he who wrote that "our Anglo-Saxon civilisation is only skin-deep", and argued that within us there lurk primitive, dangerous and sometimes uncontrollable forces inherited from our "animal past".

And there it is back again, original sin in pseudo-scientific guise, the evil beast inside that makes us do all these terrible things. Simple, romantic, and in a way comforting: it's not our responsibility, we're wicked and violent because we can't help it.

The influence of these "Darwinian" ideas on Freud was decisive. Sex, aggression, the drives inherited from the animal past are Freud's instinctive "id", and the civilised present his conscious, rational "ego". Appalled by the carnage of the First World War, Freud wrote in 1914 that it proved the fundamental thesis of psychoanalysis about the dominance of the "primitive, savage and cruel impulses of mankind" over the "feeble and dependent intellect".

Then a whole series of anthropologists and popular writers from Raymond Dart in the 1930s to Robert Ardrey and his imitators in the 1960s elaborated on the theory that the key event that differentiated man's earliest ancestors from other apes, and began their rapid evolution into ourselves, was the invention of weapons with which we could kill animals (and each other).

Dart wrote of how early man was separated from his primitive relatives by "this common bloodlust differentiator, this predacious habit, this mark of Cain." Ardrey explained: "We are Cain's children, all of us " Respectable scientists like Konrad Lorenz observed aggressive behaviour in geese and fish and then drew breathtakingly bold analogies with human behaviour, and there you had it: the complete, "Darwinian", "evolutionary" explanation for why we fight wars.

If it's true, of course, we are doomed. It would mean we cannot help fighting wars—you cannot argue with your genes—and we now have nuclear weapons. Fortunately, this whole neat package of ideas is almost certainly utter garbage from beginning to end.

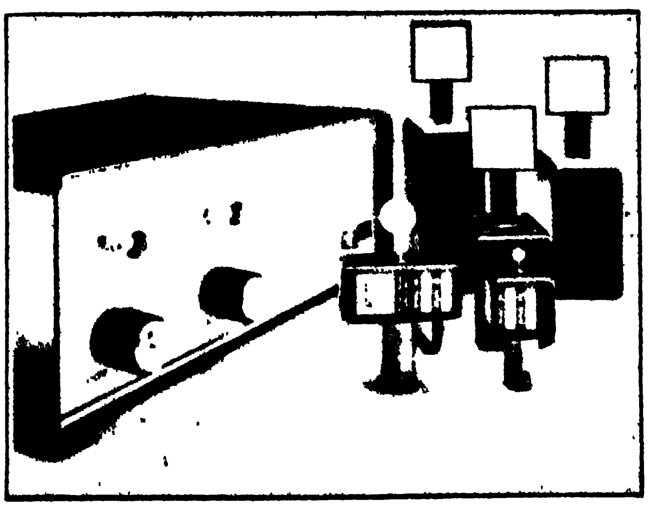
The amount we actually know about the early evolution of our own species is very slight, but there is no persuasive evidence that weapons and killing played a particularly pivotal role in making us human. Nor do apes fight wars. In any recognisable form, wars are not only a human but a specifically civilised phenomenon.

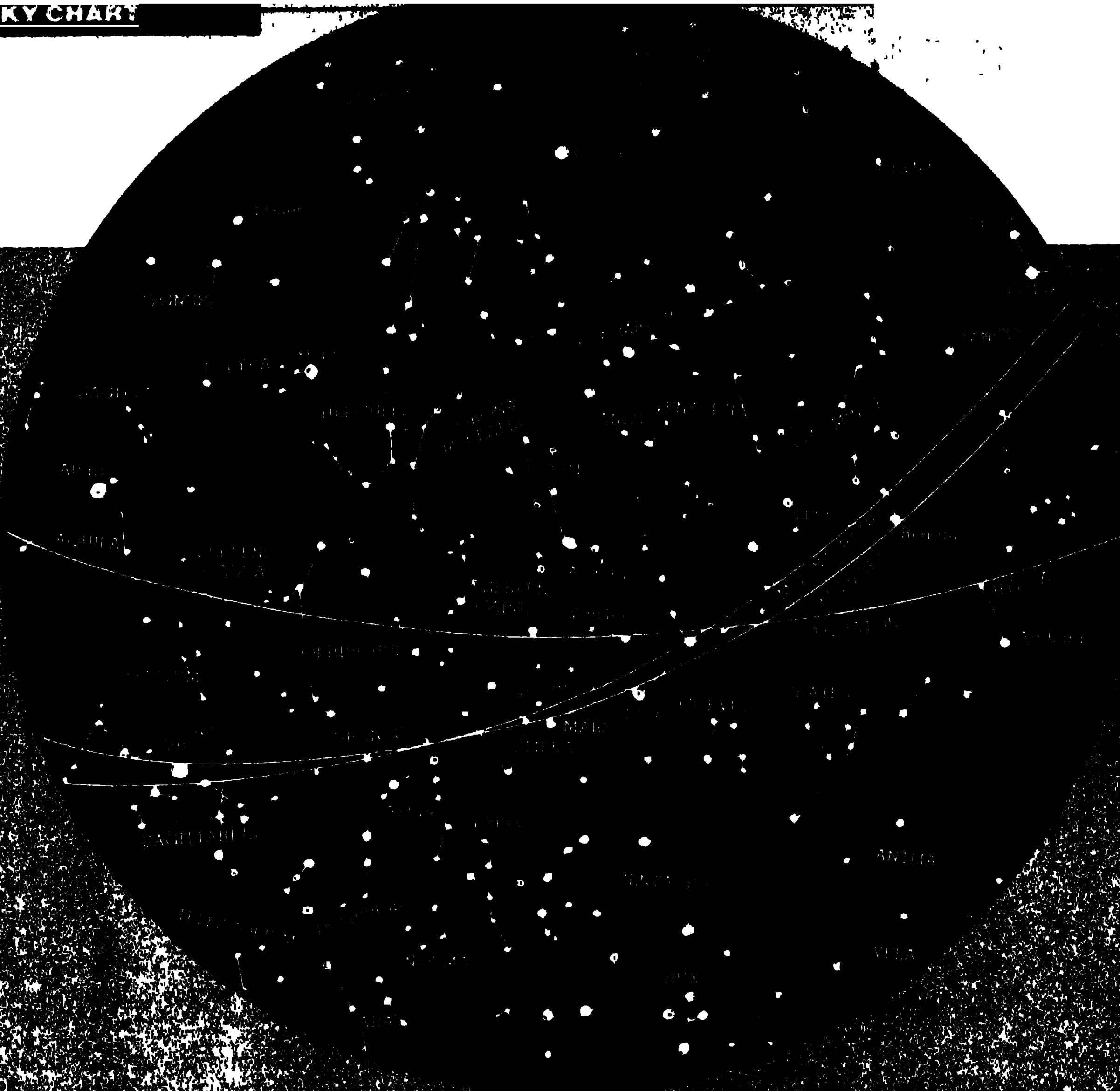
Of course we sometimes behave aggressively. Even sheep do that. But war is not just mass aggression—drunks on Saturday night, but more of them. Normal aggressive behaviour between human beings rarely leads to killing: not one man in a thousand will kill anybody else in his life, except in the service of the state. Most people have to be carefully trained and conditioned before they will even kill in war.

There is absolutely nothing in Darwin's theory of evolution itself, or in subsequent archaeological and anthropological research, to support the idea that war is "natural" (and therefore inevitable) behaviour, or the underlying belief that we operate on two levels: the civilised exterior and the beast within. Such ideas simply encourage and justify a fatalistic towards war, and have more to do with theology than biology.

Gwynne Dyer

Mr Dyer is a London-based free-lance journalist.





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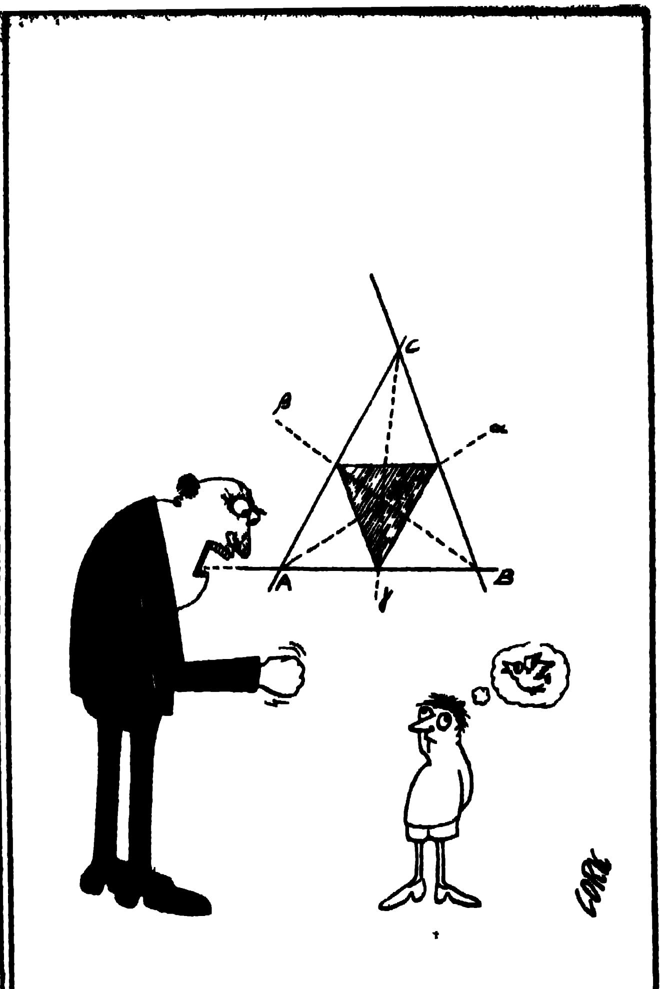
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...why do we feel HUNGRY

WE feel hungry when there is no food in the stomach On an average the stomach empties itself in a matter of three or four hours. The stomach walls then collapse and come loosely together as in a deflated balloon. At this stage the stomach undergoes periodic movements, which become more frequent and of greater intensity with time. Soon, we become aware of these gastric "growlings' or "grumblings" and associate them with the typical sensation that we call hunger These movements of the stomach therefore are called "hunger contractions"

Hunger contractions are feeble in old people and quite strong in the young They are often associated with an unpleasant painful sensation in the region of the stomach. Hungry people may also experience weakness, irritability, loss of temper, occasionally headache, nausea and apathy to mental and physical work

Scientists have studied the contractions of the wall of the stomach by having a subject swallow a thin rubber balloon attached to a long rubber tube The balloon is inflated till it touches the walls of the stomach It then reflects the changes inside the stomach, which are recorded by connecting the long rubber tube to a recording device

Study of stomach movements has helped in understanding the nature of hunger and has revealed the fact that the urge to eat does not depend entirely on sensations coming from the region of the stomach For, patients continue to eat even after complete removal of this organ Secondly intake of food is shown to depend on the activity of two centres the feeding and the satiety centres in the hypothalamic part of the brain Feeding centre is chronically active creating desire for intake of food Its destruction leads to cessation of eating (anorexia) in conscious animals On the other hand satiety centre has an inhibitory influence on the feeding centre and its stimulation reduces eating desire Normally the feeding centre is in check and satiety centre regulates the food intake of an individual

It is believed that the activity of the satiety centre is dependent on the capacity to metabolise blood glucose When the amount of glucose in the blood is low eating centre gets inadequate supply of glucose It then becomes active stimulates feeding centre and consequently frequent vigorous hunger contractions are produced Opposite is the case when the blood glucose level is high Satiety centre has adequate supply of glucose there is inhibition of feeding centre and no stomach contractions and no sensation of hunger

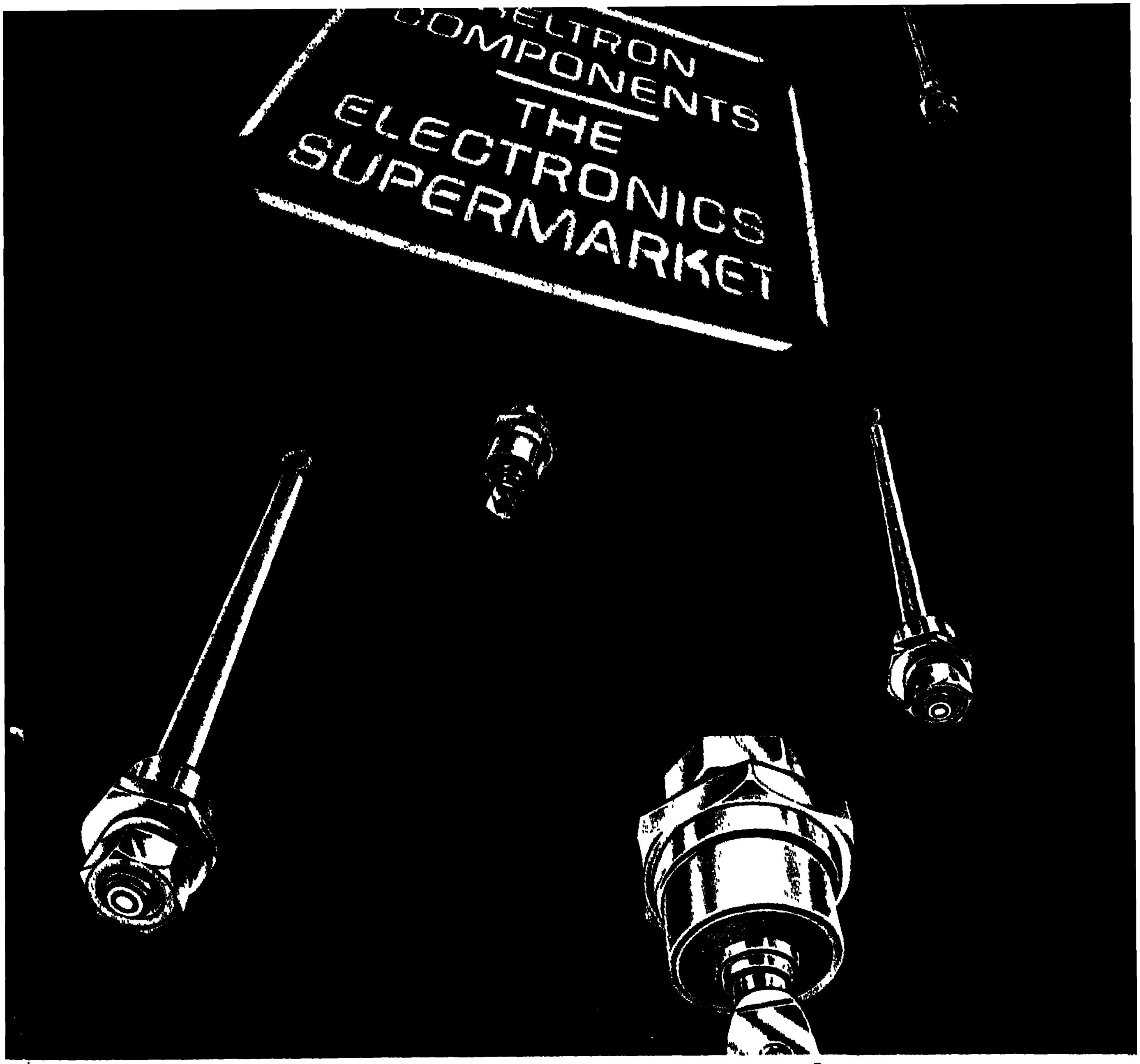
There is also a conditioned reflex associated with hunger If food is eaten regularly at a particular time each day hunger contractions will occur at that time In contrast a state of satiation is produced by mere distention of the stomach induced by placing anything into it Movements of chewing and swallowing smoking or even tightening the belt over the abdomen abolish the sensation of hunger However sleep has no effect on stomach contractions

Hunger is a protective signal to warn a person of the necessity for regular intake of nutriment If this warning is not heeded and food is not taken in time, the individual begins to lose his strength and after the first day or so the hunger pangs are reported not to be so bothersome In cases of prolonged semistarvation where a small but inadequate amount of food is available, sensation of hunger grows until it almost entirely dominates the individual s thoughts and actions Striking changes are observed during famine in the social behaviour of victims These are of importance as, as per the records of World Food Survey, "about a half of the world s people are actually hungry and under conditions of chronic semistarvation '

The term 'appetite' is often used synonymously with hunger But, it is a distinct sensation and differs in many respects from hunger Appetite is pleasant and is usually felt in the mouth or palate, but hunger sensation is unpleasant and is referred to the stomach region Appetite is the sensation of anticipated pleasure of eating and depends on odours and memory of pleasant foods It may persist even after the hunger is satisfied For example if somebody is fond of say icecream ,he will eat it even after a heavy dinner when he had filled his stomach to repletion He does this because, as we should call it, he has an appetite for icecream

P. Shanker Rao

Dr Rao was formerly Professor of Physiology at Gandhi Medical College Hyderabad He has a doctorate from University of London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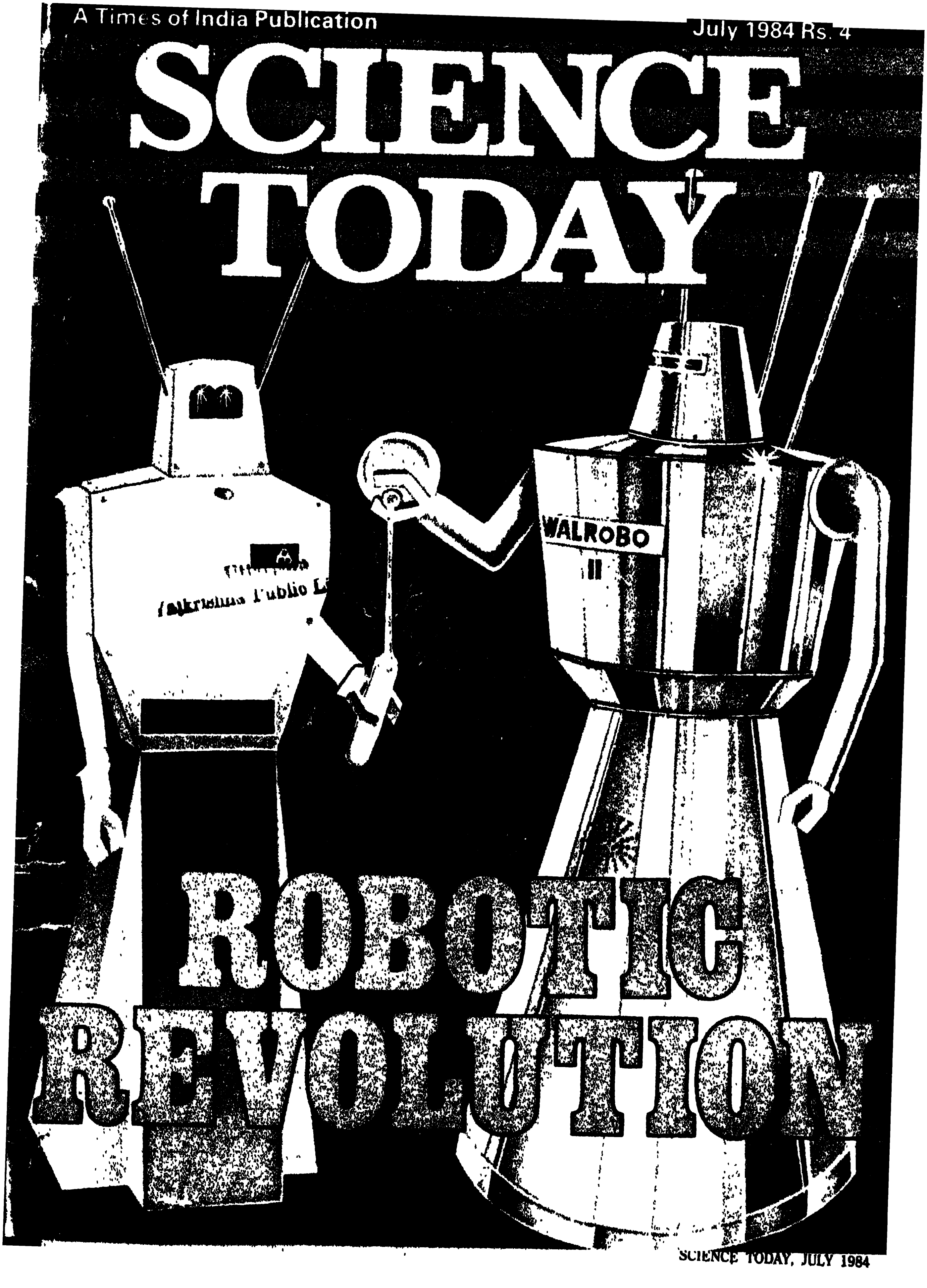
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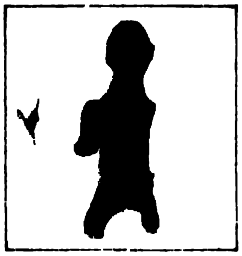
SCIENCE TODAY

Vol. 18 No. 7



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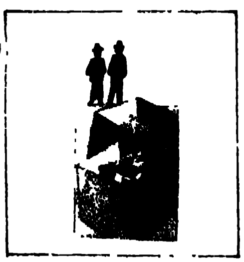

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Features

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THE annual rigmarole of admissions to the universities began a few days ago. The number of students passing the secondary school certificate examinations is growing year by year. And most clamour for admission to only a select few disciplines among those available at the university level. This always results in large scale confusion, chaos, frustration and actively encourages malpractices. All this brings no credit to a nation which boasts of the third largest scientific manpower in the world. One gets a distinct feeling that something is certainly rotten in the groves of Academe.

It was, therefore, heartening to note that at least some of the vice-chancellors chose to boldly express their misgivings at the recently concluded meeting in Delhi convened by the University Grants Commission. The primary function of universities is to create an atmosphere conducive to the pursuit of knowledge and to inculcate in its alumni a desire to devote their lives to study and research. Instead, they have been turned into mere disbursers of degrees that serve as passports to employment. The accent is on acquiring a label and not on gaining knowledge. This was bound to happen once the gates were thrown open to the masses regardless of the aptitude or ability to tread the cloistered path of higher learning. Worse, this one act has let loose a chain reaction which draws still higher numbers to the universities to obtain their own permits for seeking the daily bread.

Apart from lowering the standard of university education this populist measure has given rise to a peculiar situation: On the one hand, we have large numbers of graduates seeking jobs that bear no relevance to what they have studied—the result is underemployment. On the other hand, due to the indifferent quality of these graduates, quite a few positions remain vacant for want of suitably equipped personnel. In an industrially developing nation like ours the need for skilled tradesmen is very acutely felt. As a result of the "selective" rush to the universities many of these courses of study remain neglected. The lopsided development of our educational system was starkly highlighted by the recent emigration of our skilled craftsmen to greener pastures in West Asia that caused a virtual labour famine here.

True, politicians cannot be absolved of their responsibility for this state of affairs. They vie with each other to found colleges far and wide like so many weeds in the countryside. This might assuage false notions of prestigious "development" harboured by the masses, thus making sure of their votes.

But the educationists, social scientists as well as scientists are also equally to blame. No serious effort has been made to educate and convince the planners—and the masses—of the need to restrict entry to schools of higher learning. Even in socialist countries, university education is not for all comers.

We are acutely aware that we might be accused of advocating creation of a new casteism. But what we are suggesting is restructuring of the educational system to tailor it to the needs of our society. Underemployment as well as "misemployment" satisfies neither the individual nor the society. It only breeds discontent at all levels which then finds expression in a disastrous manner. These vice-chancellors who have raised their voice, albeit belatedly, therefore deserve to be congratulated. It is to be hoped that their's will not be a cry in the wilderness.

EDITOR

SCIENCE AND THE MASS MEDIA

I have recently returned from Japan after a long stay there, and am impressed by the high standards of your magazine which is doing a great service in promoting awareness of science and technology in India.

I can say from first-hand experience that dissemination of scientific information by the Japanese media is the major factor behind the success and fast growth of their economy. Thanks to this conditioning by the popular media, the Japanese society is well prepared when new products are introduced—be they the highly sophisticated stereo systems or an advanced personal computer. The stress in Japan is on the information content for mass appeal, rather than 'style' or 'literary heights' for the elitist appeal. In this aspect, your magazine also deserves credit for presenting highly scientific matters, garbed with humour and many illustrations.

R. GEHANI

Executive Products Developments
Nirlon Synthetic Fibres & Chemicals
Goregaon, Bombay 400063

Daylight robbers

Over and above the sources of post-harvest infestation ("Day-Light Robbers", March, 1984), the cross-infestation arising out of the reuse of old infested gunny bags deserves our attention. It has been experienced that even the larvae of insect pests like *Trogoderma granarium* and *Rhizopertha dominica*, etc, hosted by old infested gunny bags, cross-infest the fresh grains filled in such bags. Especially, if the latter are not dipped in malathion solution or fumigated with EDCT mixture prior to their reuse.

Also, a part of insect and fungus infestation of foodgrains and pulses takes place right in the fields when crops are maturing. As such, an integrated approach of the preharvest and postharvest control measures is necessary to contain the robberies of the "Day-Light Robbers"

JAYDEV JANA

Dy Asst Director
(Inspection & Quality Control)
Food & Supplies Dept
West Bengal

Animal communication

The article "How animals communicate" (May, 1984) was marvellous. The photographs of the lovable creatures were spectacular. Animals deserve more respect and love than human beings, who don't care for humanity itself.

V VIJAYAKUMAR ATRI

22, SBM Colony Road
Bangalore 560 050

This refers to the letter "CIBA-GEIGY overrides safety clauses" by Dr. M. Bhide (February, 1984).

Dr. Bhide has again raised the issue of the propriety of exposing human volunteers to insecticidal sprays to gauge any untoward effects on human health. The author has quoted the experiments conducted with Nuvacron in 1975 in India and Galecron in Egypt in 1976 in which aerial spraying was done with human volunteers present in the field, to scientifically observe any undesirable effects on human beings owing to insecticides sprayed under field conditions. The tone and language in which Dr. Bhide's letter was couched gives an incorrect impression that our Company is indiscreetly subjecting human beings to insecticidal spraying for scientific experimentation without any regard for their safety. We would like to clarify this erroneous impression and put this matter in proper perspective.

The purpose of exposure measurements of the kind quoted by Dr. Bhide is to determine whether people working with or near agrochemical products are sufficiently protected under realistic field conditions. These measurements are not to be used as toxicological tests. In principle such measurements are carried out only when the results of thorough prior toxicological tests conclusively show that no harm will come to the people who participate in the measurements. This procedure is in conformity with the principles of the World Health Organisation which has issued special guidelines on this subject.

The experiments conducted with Galecron in Egypt were in accordance with the requirements of the Government of that country. Experiments in India were conducted strictly in accordance with the instructions received from the Central Insecticides Board, Directorate of Plant Protection, Quarantine & Storage of the Government of India vide their letter No. 91-17/74-PP&L dated 11.3.75. The same authority had asked us to repeat the trials as per their letter No.91-17/74-PP&L (Vol.II) dated 27.9.75. The Government officials fully collaborated with our scientists in these experiments and observations were taken in their presence and later certified by them.

The participants in the exposure measurements with Galecron, were all volunteers. The participation of teenagers, was on the basis of their parents' consent. Juvenile farm workers participated because of the special local circumstances—they have always been intensive workers in the fields.

Likewise, the consent of volunteers for experiments with Nuvacron was obtained. The volunteers in both the cases were from among the people who are normally engaged in the spraying work and are generally aware of the symptoms of pesticides poisoning. CIBA-GEIGY staff members were also among the volunteers. The volunteers, therefore, participated in these trials with full knowledge of the symptoms of pesticides poisoning. No deleterious effects were observed on human beings as a result of their exposure to insecticidal spray.

With regard to the side-effects like diarrhoea, dizziness and headache, allegedly suffered by the Egyptian farm workers, these symptoms are not related to Chlordimeform (active ingredient of Galecron) nor were they observed in the farm workers before or after the exposure measurements.

A. K. BAHL

For and on behalf of
HINDUSTAN CIBA GEIGY LIMITED,
Bombay

IIT courses for the brilliant

The Indian Institute of Technology, Bombay, is offering two postgraduate programmes from July 1984, for the brilliant and motivated students.

The M Tech. programme by research offers a three-semester M.Tech. programme by research in all the specialisations and interdisciplinary area in which regular M.Tech. programmes are being currently offered.

A Five-Year Cooperative Integrated M.Tech. programme in chemical and mechanical engineering enables students to get their postgraduate degree directly within a period of five years

The students will be alternating their regular course work with 3 to 4 stints of paid practical training during the summer vacations A number of courses on various aspects of industrial practice, finance and management will be offered jointly by the Institute and experts from the industries.

The programme will be supported by the sponsorship from industrial organisations who may also be potential employees for the successful students. Students will receive Rs. 400 to Rs. 500/ per month for all summer training sessions in the first 3 years. Rs. 600/ to Rs. 800/ per month will be given for the entire duration of the last two years.

H. C. PAL CHOUDHURY

Public Relations Officer,
IIT. Powai,
Bombay-400 076

Can poison bring about life?

PROFESSOR Clifford Mathews from the University of Illinois, USA, believes that one of the deadliest gases, hydrogen cyanide, may have been the building block for the primitive protein molecules from which life arose on the Earth.

Among the most abundant elements in the universe are oxygen, hydrogen, carbon and nitrogen, the last three being the constituents of hydrogen cyanide. In their atomic form they are also the main elements in living matter.

According to Prof. Mathews, clouds of hydrogen cyanide created by the action of sunlight on methane and ammonia probably encircled the Earth. Through polymerisation hydrogen cyanide reacted with itself forming a yellow-brown solid. This proved to be the carbon-nitrogen backbone needed for a primitive protein.

Prof. Mathews thinks that hydrogen cyanide polymerisation may be the main organic reaction in the universe. The existence of cyanide-type molecules in outer space further fortifies his thinking.

Space spin-offs

IN a space programme, there is hardly any room even for the slightest of errors. And no effort or expense is spared when it comes to protecting the crew against all odds. A flawless mission, therefore, leans heavily on a totally reliable and foolproof system from the start to the finish.

It is not surprising, that a technology which meets such stingent safety standards should result in numerous products and processes providing comfort to us, earthlings.

In a space mission, right at the beginning, the astronaut has to be protected from the searing heat of the flame produced during take off. An excellent silicon-based material has been developed for thermal shielding. Even when one side of a tile is red hot, the other side can be safely held in hands!

An insulating film developed essentially for protecting the space craft from solar radiation during unmanned flights, is being used for shielding homes from heat and glare. Even a thin coating of the film on doors and windows can not only give protection against heat in summer, but also can trap the heat indoors in winter.

A tiny gadget, based on a miniature circuitry, to protect people—in industry as well as at home—from electric shocks, a pen sized ultrasonic transmitter which can be used to sound an alarm or open doors automatically in case a person faces danger are all fall-outs of space.

A very light weight synthetic material (temper foam) meant for sealing and cushioning in space crafts is proving a boon to sportsmen. Used in helmets, baseball chest protectors and soccer shin

Computer-aided trouble shooting system known as CATS-1 identifies the causes of malfunctions in a locomotive

Instant "Mr. Fix-It"

RESEARCHERS in the US have come up with a computerised troubleshooting system that promises to transform even the most inexperienced mechanic into an instant "Mr Fix-It".

The portable electronic tool—actually a small computer and associated hardware—combine recent advances in the fast growing field of artificial intelligence, which involves "teaching" computers to mimic the human thought process.

The new system is an example of one branch of this emerging science known as "expert systems." Creating such systems involves programming a computer with the knowledge, experience, and decision-making prowess of human experts in a given field. Developed at the General Electric Research and Development Centre in New York, USA, the new system will be put to work troubleshooting GE built locomotives.

"And this, mind you, was originally designed for Neil Armstrong"

guards, its capacity to absorb shocks is said to be shocking indeed.

Rechargeable foot warmers, helmet visors to provide fog free, near perfect vision, an emergency lighting system which needs no servicing for as long as ten years all owe their existence to the space programme.

An important spin-off, however, is a laser system which can tell from far (900 m away) how much smoke is being dispersed from an industrial chimney. The entire equipment can be mounted on a van and moved from place to place. Unlike the conventional methods this does not result in the disruption of normal factory operations.


AVIATION WEEK AND SPACE TECHNOLOGY

Rescue jobs up in the sky

THE Indonesian Palapa B-2 and Western Union Westar 6 spacecraft may not be totally lost in space—not yet. National Aeronautics and Space Administration (NASA) of the US is planning a rescue mission during one of the future shuttle flights.

Palapa B-2 and Westar 6 were taken to space on the tenth shuttle flight. They failed to reach their geosynchronous orbits and could not begin normal functions.

The hopes of rescuing the spacecraft have brightened following the success of the astronauts in repairing the Solar Maximum Satellite using the manned manoeuvring unit (SCIENCE TODAY, May 1984) during the 11th shuttle flight. If Indonesia decides in favour of it, the rescue mission would be possible as early as October-December.

Single vaccine against 12 diseases

VACCINES against viral diseases like herpes, hepatitis and influenza have been made by modifying the existing smallpox vaccine using a technique that theoretically can be used to make vaccines for any infectious disease. It is even possible to make a single vaccine to protect against as many as 12 diseases, says Enzo Paoletti in a research paper submitted to the National Academy of Sciences, USA, in December.

Even though the vaccines for hepatitis, influenza and some forms of herpes already exist, the new technique may lead to cheaper, safer and easier-to-use vaccines. But it would be at least two years before the vaccines are ready for human trials.

Smallpox vaccine is made from cowpox virus, or vaccinia virus, which is similar enough to smallpox, to provoke the body to build up its defences against smallpox, and thus prevent subsequent disease.

Paoletti has used genetic engineering techniques to insert genes from various infectious agents into vaccinia virus, creating viruses that provoke immunity to those other infectious agents. Thus the technique has potential for both bacterial as well as viral diseases and perhaps parasitic disease—which is an extreme problem at the global level. Beyond the fact that it may be applicable to so many diseases, the advantages of the new technique are that it produces vaccines which require no refrigeration, making them suitable for use in remote areas. They are also easier to administer. They require only a small skin scratch and not an injection. Yet another advantage is that vaccinia virus stimulates both of the two main components of the body's immune system—antibodies and white blood cells. The scheme would also be useful for making special vaccines against local outbreaks of rare viruses.

—Wijaya Altekar

'Image' is as good as real

YOU must have heard about the "Jaipur foot", which has brightened the lives of many amputees, but the Americans have gone a step further. 'Image', an artificial breast has made news in the US (*Newsweek*, May 21, 1984).

"Keeping in view my image in society, I've ordered the American version."

The designer Arthur Pfrommer uses the same conventional medical silicon as standard pouches—but with a difference. The device is 'made to order' and it has another plus point. It requires no cumbersome undergarment to hold the prosthesis in place and hence imposes no strain on the shoulder.

First, a plastercast of the woman's chest is made. Then a clay sculpt identical to the woman's normal breast is made—complete with contours Using this as a mould, a silicon pouch is filled with silicon gel, and coloured to match the user's skin. Now 'Image' is ready for use. The woman attaches this to her body with any sticking medium—liquid, tape or medical adhesive.

The major drawback envisaged is that it is expensive than most artificial breasts. But that shouldn't deter many fashion-conscious ladies.

Paint once for all the time to come

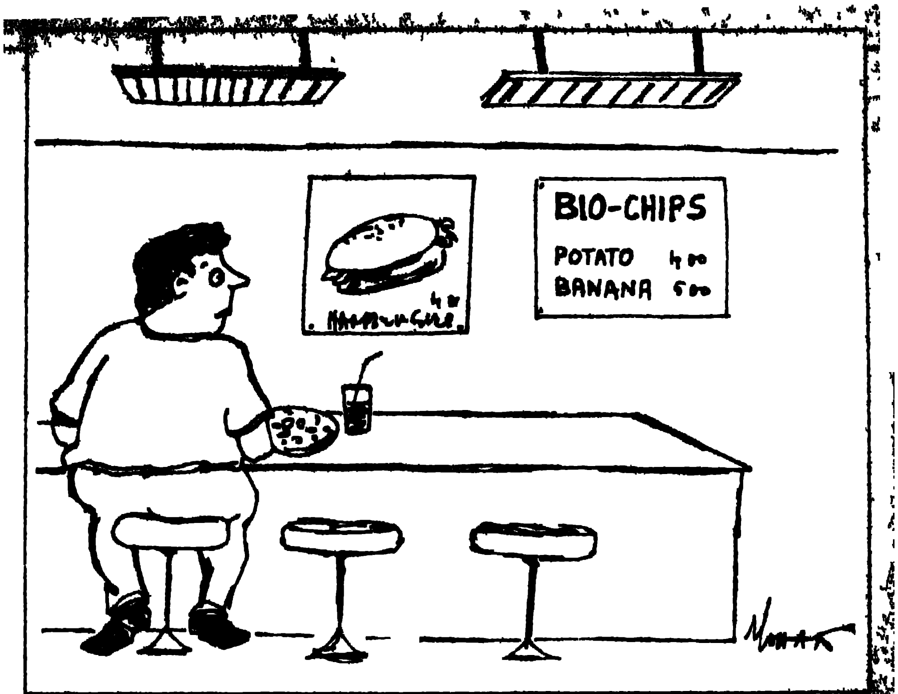
A PAINT that lasts forever has been developed by a research centre in Surrey, UK. This anti-corrosion (anti-rust) paint can be used on almost all metal structures, including cars, offshore installations, bridges, factories, etc. The paint is produced using a complicated but well-known phenomenon—ion exchange. Ion exchange is a reversible chemical reaction, involving an ion exchanger (a solid, and a fluid usually water) by means of which ions are interchanged from one substance to another.

The principle of ion exchange is used in softening water, clearing of wines and other processes. In the new paint preparation, the application is slightly complex. Corrosive molecules in the environment attack metal structures, destroying their protective coats of paint. The new paint, contains a pigment which lies dormant, until activated by a potentially corrosive agent like the chloride in salt spray or sulphate in acid rain. The activated pigment, then locks onto the corrosive threat, and prevents it from attacking the underlying metal. In theory the reaction is reversible and periodic washing of the paint would wash away the corrosive substances, leaving the pigment free to act again if necessary.

Good news for motorists

THE one thing that motorists and cyclists fear most is a flat tyre. The latest in the making for a care free drive is a tyre made of solid rubber.

The speciality of the tyre is that it flexes when it hits a bump. The flexibility comes from the V-shaped spokes visible behind the conventional spokes *(see below)* that connect the rim to the hub. The V-spokes are so designed that they bend in the middle and the rim moves off centre for an instant when the tyre has to absorb a shock. The conventional spokes attached to a ring at the centre of the wheel keep the rim from bending.



Coming computers

IS silicon chip for ever? The answer seems to be a firm no. Soon it may have to contend with two rivals. The first, gallium based, and the second chemical-based.

It was known since 1960 that in superlattices consisting of gallium-arsenide and aluminium gallium-arsenide, extra high electron mobility could be realised. This is the basis of HEMT (high-electron mobility transistor), a new transistor. It has a low switching time (10 pico seconds) and consumes very little power (generating very little heat). Within five years the gallium based chip is expected to find extensive uses in supercomputers, instruments and microwave amplifiers.

A chemical-based computer, on the other hand, would use organic molecules or custom-designed proteins as components. The prime advantage of these is said to be their astounding efficiency. Recent advances in biotechnology (immobilised enzyme technology, genetic engineering technology, etc.) have in fact, opened up the doors to these chemical based computers. When a chemist comes out with a polymer, whose electrical properties are congenial for computing, this molecule could be reproduced in large quantities through DNA technology and a bio-chip will become a reality. The possibilities with a bio-chip are truly mind boggling. As in biological systems it is hoped that the components in a bio-chip can be spaced so densely that the density may even reach 10 million times that of today's silicon chips. The silicon chips are planar but biological chips may be more like the brain and may even possess changing moods! If all this sounds more like science fiction, who had thought of the silicon chip when the first electronic computer was born?

Sneezing in the sunlight

NEXT time you step out from a shaded place into bright sunlight, watch out. You could find yourself sneezing involuntarily. About one third of all human beings sneeze in response to bright light. Moreover, this reflex may even be hereditary according to a scientist at the Johns Hopkins University, USA.

The scientist, Stephen Peroutka, who invariably sneezes twice when walking into bright sunlight from indoors, discovered that his four-week daughter also sneezed twice while going for a walk in the Sun. Further investigation showed that Peroutka's father and brother (but not mother) also possessed the photic sneeze reflex. The trait appears to be passed genetically with a 50 per cent chance of inheritance. Out of the 25 Johns Hopkins neurologists only one knew about this reflex— an involuntary action (but nine claimed to have experienced it). Earlier in 1964 an epidemiological survey of the reflex was conducted by Henry C. Everett, now a psychiatrist in Massachusetts. Everett found that more men than women have the reflex and that it is *not* associated with hay fever or other allergies.

No one knows why the trait occurs. Peroutka suggests it might be a protective response—to prevent staring at the Sun. Everett, who also sneezes in the Sun, has a private theory: Only the best people have the reflex!

Scientists—prisoners of conscience

ON 3 March, 1984, an international campaign directed by prominent scientists succeeded. The campaign was intended to release the famous mathematician Professor Jose Luis Massera, who was unjustly imprisoned by the junta in Uruguay since 1975. Prof. Massera, known for his splendid work on differential equations and as the leader of the Communist Party of Uruguay, suffered a great deal due to the horrible prison conditions, extreme climatic influences, his deteriorating health and torture.

International Campaign—Massera, was supported by leading scientists, including 47 Nobel Laureates and prominent scientific organisations like the Canadian Committee of Scientists and Scholars, the American Mathematical Society, etc. The widely distributed bulletin, *International Campaign—Massera*, played a vital role. Prof. Massera was finally released on 3 March, 1984. Now he is in good spirits and reasonably good health, and has been given the choice to leave Uruguay and, if he wishes, to return to Uruguay.

The campaign doesn't just end here. It has now launched a movement to rescue two prominent scientists, Yuri Orlov and Anatoly Shcharansky, who are prisoners of conscience in the USSR. This campaign is directed by two mathematicians, Henri Cartan of France and Israel Halperin of Canada. In the words of Prof. Halperin, a distinguished mathematician and Secretary of the Canadian Committee of Scientists and Scholars, "Our underlying objective is to build *public opinion* and to strengthen public opinion, *by practice*, so that it becomes a vital force in protecting acceptable mor ality".

Yuri Orlov is a physicist and an internationally recognised expert in non-linear focusing electron accelerator technology. In 1973, Orlov wrote an open letter to President Brezhnev defending the great physicist and Nobel Laureate, Prof Sakharov. He became the founding member of the Soviet group of Amnesty International and was soon dismissed from his post in the University. But Orlov continued his rebellion by protesting against the deportation of Alexander Solzhenitsyn. In 1976, he organised the Group to Assist the Implementation of the Helsinki Agreements in the USSR. He also published an article abroad deducing that the concentration of political and economic power, in the hands of a centralised bureaucracy, inevitably leads to the loss of freedom for individuals.

Orlov was arrested and tried for anti-Soviet agitation in 1977, but was denied the right to call witnesses in his defence and not permitted to cross-examine those who were called to speak against him. When given an opportunity to speak, Orlov openly admitted that he was in favour of gradual democratic changes in the Soviet society and that his attitude towards the existing order, as it was to any other state, was one of critical analysis. Orlov was subjected to seven years of hard labour, to be followed by five years of exile.

The other victim of Soviet injustice is the reputed computer scientist, Anatoly Shcharansky. He was employed at the All-Union Scientific Research Institute of Oil and Gas till 1975. Due to his repeated applications for permission to emigrate to Israel, he lost his post. But he then became the most active participant in the Soviet human rights movement. With his mastery over English, he acted as a superb interpreter both for the Helsinki group, of which he was a member, and for Prof. Sakharov. The Soviet press printed tales of Shcharansky's contacts with foreign press correspondents, and labelled him as an American spy. In 1978, he was convicted of anti-Soviet agitation and high treason, sentenced to 13 years of which three were to be in prison and 10 in hard labour camp. The trial of Shcharansky, from which observers were excluded, and the sinister implications of suppression of all who criticised the official line, aroused deep concern in the West.

Shcharansky has now suffered brutal prison conditions for seven years with his health deteriorating seriously but with indomitable spirit he continues to protest. When the authorities cut-off all his contacts with his mother he went on a hunger strike, but he was given forced feeding to avoid the scandal that his death would have caused.

Prof. Sakharov, leader in the Human Rights Movement, stated: "...Shcharansky lived such an open life that it completely precluded any kind of secret activity. He spoke openly against the violation of the rights to emigrate and against other violations of human rights".

There has been widespread global protest against the beastly treatment of Orlov and Shcharansky. The Canadian Parliament passed a resolution expressing its disappointment and criticising the attitude of the Soviet Union, and for rejecting the offer of the Canadian Government to give landed immigrant status to Shcharansky. Even the President of France, Francois Mitterand, appealed in vain to two Presidents of the USSR to release Shcharansky. During March and April of 1984, thousands of individuals and organisations communicated to the secretary of the Communist Party of the USSR that they supported the International Campaign—Orlov and Shcharansky.

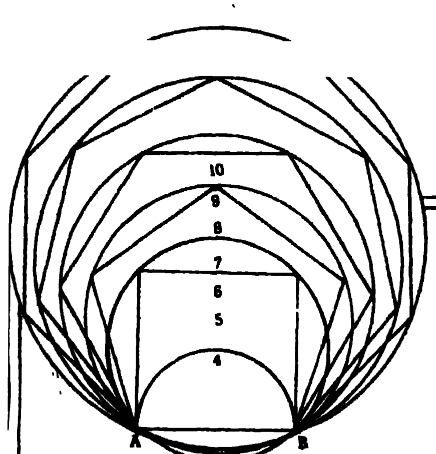
The Campaign deserves the support of intellectuals, individuals and organisations all over the globe. It will be of great benefit if sympathisers in India of the International Campaign—Orlov and Shcharansky, write their protest or what they think of the treatment of Orlov and Shcharansky to the Ambassador of the USSR in New Delhi.

Scientists and the human right movements all over the world are confident that they will be able to rescue Orlov and Shcharansky, because even a superpower like the USSR cannot stand up to a never-ending, escalating spotlight of shame. The campaign's support is impressive and constantly increasing. The International Campaign is supported by 47 Nobel Laureates and several reputed scientists and individuals, and organisations like the Canadian Committee of Scientists and Scholars, Committee on Human Rights of the National Academy of Sciences (USA), Comite des Physiciens Francais, Comite des Mathematicians (France), Society for Industrial and Applied Mathematics (USA), Committee of Concerned Scientists (USA), New Zealand Mathematical Society, the Ontario Federation of Labour (Canada), etc.

Those sympathetic to the Soviet government will dub this Campaign as anti-Soviet or anti-communist. There is no need to fear such types of routine charges. The prisoner of conscience whom the campaign just helped to free, Prof. Massera, is a leading proponent of communism and is the member of the Communist Party of Uruguay; and this was known to all the supporters of the Campaign. No takers!

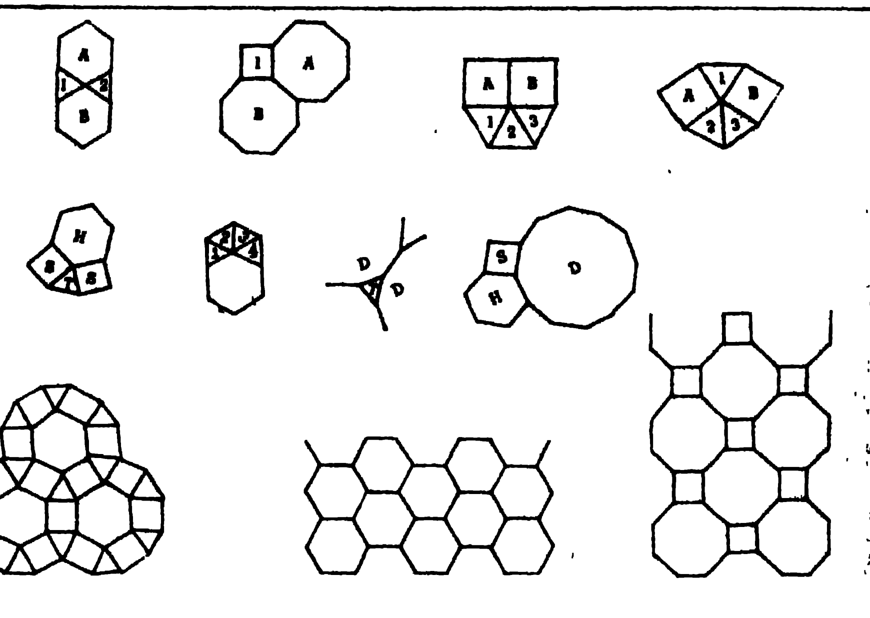
Wilfred D'Costa

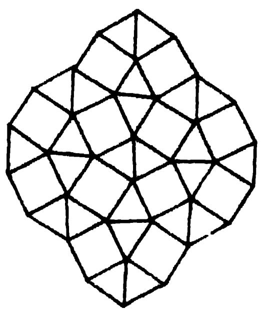
Mr. D'Costa is Chairman of the Indian Association of College Going Scientists.



Construction of a regular polygon

Geometry of TESSELLATION





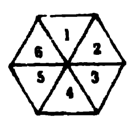


Fig. 1

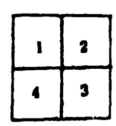


Fig. 2

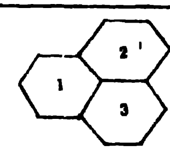


Fig. 3

THE art of interior decoration many a time draws inspiration from the geometry of tessellation. The knowledge of this geometry leads to a vast treasure of beautiful designs *(see figures above)* which can be drawn on tiles used to decorate floors, walls or ceilings; on rugs, linoleums or carpets and while cutting precious stones.

An array of patterns fitted together to cover a whole plane is called a tessellation. The common patterns used repeatedly are the regular polygons such as equilateral triangles, squares, hexagons and so on. Many designs can be obtained even with other types of polygons such as octagons and dodecagons. The simple rule to be remembered is that the sum of angles around any vertex must be equal to 360°, that is, 2 straight angles. Naturally fewer than 3 and more than 12 sided polygons need not be considered as there should be at least 3 polygons around the vertex.

Thus we have to select the nature and number of polygons such that the sum around any vertex will be 360°. As the interior angle of a polygon is equal to $\frac{n-2}{n}$ of a straight angle, the number of polygons of the same sides can easily be worked out. Six triangles, four squares and three hexagons can be fitted around a given point and the pattern can be repeated *(see Fig.1, Fig.2 and Fig.3 above)*.

If one is interested in a combination of regular polygons then the following equation can be solved empirically for integral solutions:

$1/3\,T + 1/2\,S + 2/3\,H + 3/4\,O + 5/6\,D = 2$

where T, S, H, O and D represent the number of triangles, squares, hexagons, octagons and dodecagons respectively. The coefficients, namely, 1/3, 1/2, 2/3, 3/4, and 5/6 are the interior angles of the above polygons in terms of a straight angle (180°), that is, 60°, 90°, 120°, 135°, 150° respectively. The right hand side is the desired sum, that is, 2 straight angles (=360°). The polygons of 5, 7, 9, 10, 11 sides are not included as no integral solution is possible with these polygons.

Some solutions are tabulated alongside.

No.	Triangles	Squares	Hexagons	Octagons	Dodecagons
1	2	—	2	—	—
2	—	1	—	2	—
3	3	2	Two patterns		
4	3	2			
5	1	2	1	—	—
6	4	—	1	—	—
7	1	—	—	—	2
8	—	1	1	—	1

B. A. Naik

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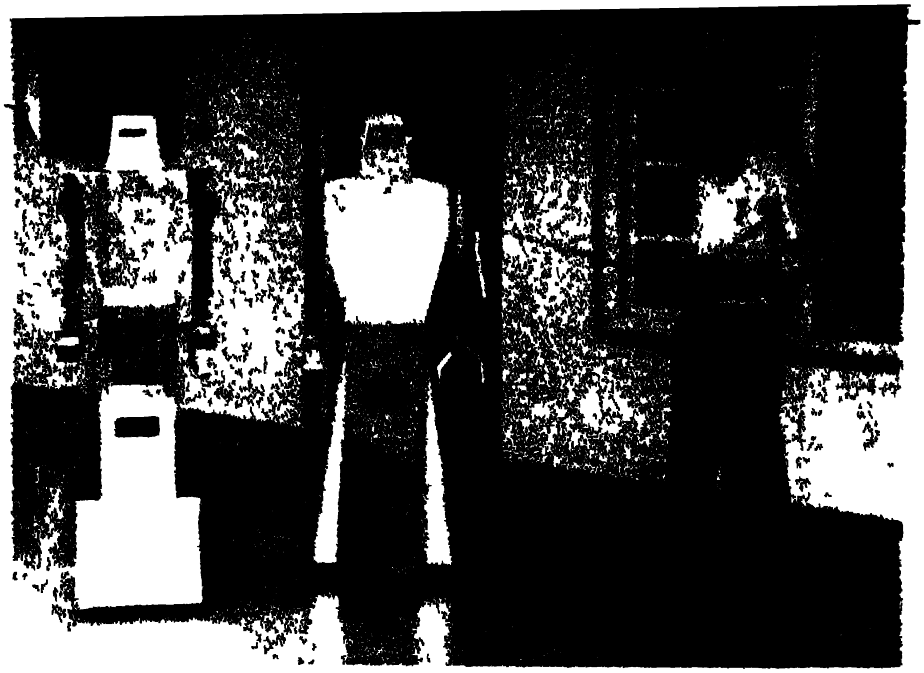


Prototype robot and Walrobo I under test

"To you a robot is a robot Gears and metal. Electricity and positrons. Mind and iron. Human model! If necessary, human destroyed. But you don't know them. They're a cleaner, better breed than we are."

Dr. Susan Calvin, 2057 A.D. in **"I, ROBOT"**
by Isaac Asimov (1950)

RISE OF THE ROBOT

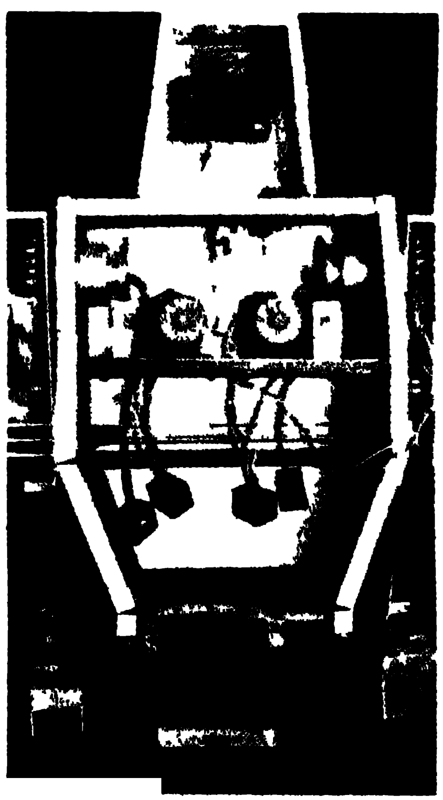
S. A. Khan

SCIENCE fiction is often dismissed by many serious-minded scientists as a mere idle flight of fancy There is, however, no denying that this branch of literature has spawned many concepts which at the time might have appeared pretty extravagant but later, when exploited and realised, have significantly contributed to the welfare of humankind.

It is thus not surprising that science fiction has played a prominent part in establishing the robotic image, from Mary Shelly's Frankenstein, the ultimate robot, and MGM's "Demon Seed" in which Julie Christie is the victim of a runaway robot, to the Artoo Dee Too of "Star Wars "

The term robot was first introduced by Karl Kapec in his play 'Rossum's Universal Robots' in Czechoslovakia in 1917; the word 'robota' in Czech signifies a kind of slavery. The term has come to stay with us, though the meaning has changed. After Kapec's play of 1921, "Metropolis", a German film of 1926 depicted robots. A talking android named Electro and a dog robot Sparko, made their appearance in 1939 at the New York World's fair

Inside view of the robot



Robots resembling human beings or animals abound in legends and literature The authenticity of these tales is to be established however. For example, St. Albertus Magnus the 13th century German philosopher was allegedly served by a robot butler. This metallic major domo was said to have been destroyed by Magnus' celebrated pupil, St. Thomas Aquinas, who considered it unholy.

For modern times, the Robot Institute of America defines a robot as "a reprogrammable multi-functional manipulator designed to move material, parts, tools or specialised devices, through variable programmed motions for the performance of a variety of tasks" This definition however is inadequate as it covers only one of the three types of robots

Types of Robots

These three categories of robots are based on their principles of operation

1 Remote Controlled Robots:

These robots are controlled by an operator using radio signals, or infra-red to ultrasonic beams Radio control is possible over long distances, if a transmitter of appropriate power/range is used Infra-red and ultrasonic controls do not work if any physical barriers are present between the operator and the robot While the radio-control and infra-red systems work instantaneously the ultrasonic method is slower, as it depends on the lower velocity of sound waves.

In all the three systems, the transmitter sends coded signals to the receiver located in the robot. These signals are decoded to activate controls for various functions of the robot: A large range of controls, can be incorporated into the system providing an equal number of functions to be performed.

The main drawback of such robots is that a human operator is required to control it, and that the robot has to be visible to the operator—either directly or through a video system. A major advantage is that decision-making lies in the brain of the operator, substantially reducing the cost of electronics hardware and software required for such operations.

2. Programmable Robots:

Robots in this category have the sequence of their operations stored in a micro-computer. The instructions can be fed through magnetic tapes, discs etc., or stored in the memory. Alternatively the instructions can be given by "teaching" the robot. This involves taking the robot physically through the programme cycle and storing these parameters at the beginning and end of each such operation. The robot "remembers" this sequence of operations stored in its read-write memory and repeats them any number so desired. For such teaching programmes, encoders are generally used (shaft encoders, linear movement encoders, potentiometers etc) These convert the mechanical parameters into electronic equivalents before storing

3. Sensor controlled Robots:

The third category of robots have electronic sensors interfaced with microprocessors to control their operation. The sensors "sense" the environment including objects on which operations have to be performed They pass on this information to the microprocessor which controls the robot operation based on these inputs

Examples of sensors for these applications are tactile (touch), optical, proximity, force, visual, temperature sensors etc. Tactile sensors detect the presence of an object or its profile by actual contact, while proximity sensors do so from a distance. Optical sensors use light or infra-red beams, generally lasers, to assimilate information about the object. On the other hand, visual sensors use cameras and pattern recognition techniques for recognition of objects by their size, shape, colour, etc. Force sensors, are used to regulate the pressure applied by the robot manipulators on objects to be handled. The ability to "crush a nut but hold an egg' comes from this type of control.

Sensors are used as input devices for microprocessors to provide information about external conditions and motors or other actuators are output devices which are controlled by the microprocessor to act on information provided by the sensors. This decision-making lies in the soft-ware programme of the microprocessor.

An Indian experience

Robotics is a confluence of three disciplines; mechanical engineering, electronics and computer technology. In the case of remote-controlled robots the prime emphasis is on the first two and a successful mating of mechanical engineering with electronics is called for. The term "mechotronics" is now being used to define this compound technology. While mechanical engineering and electronics are quite advanced in their own ways in our country, mechotronics has not received much attention until quite recently

Now this has changed, due to the relatively easy availability of low-priced control systems based on microprocessor devices All the same in robot development projects, two hurdles have to be overcome: Lack of special devices in the country, together with the non-availability of technical literature covering special items of interest. The relatively undeveloped indigenous component.

Despite these constraints the first experimental robot was developed and demonstrated at the Hyderabad Science Society in July 1981. This was fabricated using a fairly large component of surplus market stocks.

The motive power for the robot mainly came from electronic motors. Since the robots have to be mobile battery operation of the entire robot was necessary. This limited the choice of motors to low voltage DC types. Rechargeable, dry-electrolyte type of sealed batteries of indigenous manufacture were tried initially. These proved to be inefficient, hence lead-acid batteries of the type used in motor cycles were later incorporated.

Based on the experience gained on the experimental robot, a final version was designed and built in January 1982. This was displayed at the Imtex-82 in Bombay and the robot attracted large crowds of enthusiasts at this exhibition.

An advanced version was built and demonstrated at the AIEI Trade Fair in Delhi in January 1983. This was designed and built jointly with the Walchandnagar Industries Limited, Machine Tool Division, Chinchwad.

The specification or a vital profile of one of these robots given below and the accompanying photographs will convey an idea of their general features

The robot is 1.55 m. high and weighs approximately 60 kg. It moves on three sets of wheels. The arms have a length 0.6m and can lift weights upto 2.5 kg. The arms can swing freely almost a full circle, so can the wrists rotate. The grips have a maximum opening of 110 mm with a maximum sensed force of 2.5 kg. Five batteries of 6 volts each provide the power for five different motors of 0 06 H.P. each. Display of robots has created a general awareness that the robotic age has dawned in India. However, a national thrust in this direction is yet to start, although, according to a senior official of the Department of Science & Technology, robots will be used in many locations in India by the year 1990. But apart from a handful of academic institutions, the industrial sector is the only one which seems to appreciate the importance of this technology, although the Department of Atomic Energy, Defence and Space Research Organisations could

derive immediate benefits from it. Advanced robots will require sophisticated sensing systems and work in this direction is now being carried out.

One question that is frequently asked is whether robots are relevant to the Indian situation since there is an over abundance of manpower. There are two important considerations in favour of this technology:

1. Robots are of invaluable help where the precision required in production is not possible by using human labour. This includes the quality-quantity product factor. To be able to sell our products in an increasingly competitive international market, obsolete technology has to be discarded and replaced by an advanced one.
2. In hazardous locations there is hardly any other option. Areas of radioactivity, chemical toxicity, high temperatures, explosive potential warrant the use of robots. For instance, in most developed countries, welding and spray painting are also considered hazardous due to the high incidence of tuberculosis among human workers in these professions.

Potential

Robotics has become big business abroad. By 1985, Japan will produce more than one billion dollars worth of robotic equipment annually. By 1990, the annual demand in the U. S. alone is estimated at three billion dollars. The international annual demand could well exceed five billion dollars by then. India could well try to obtain one per cent of the trade i.e. Rs. fifty crores of export annually.

Conclusion

Computers have been accepted in India for many areas of application. With the development of microprocessor technology the next step is to develop robotics as a major R & D effort. However, a change of attitudes at many levels is necessary to implement such a programme.

Henry Brooke Adams, had said in "The Degradation of Democratic Dogma" (1919), that "The future of thought and of history lies in the hands of physicists, and the future historian must seek his education in the world of mathematical physics. A new generation must be brought up to think by new methods, and if our historical departments in the Universities cannot enter this next phase, the physical departments will have to assume this task alone." This statement is truer today than when it was first made.

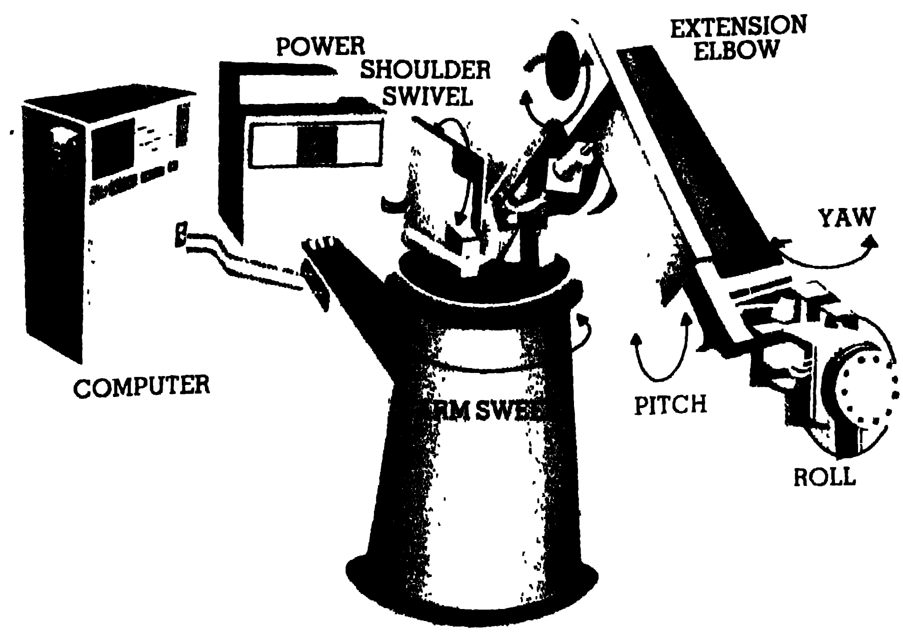
Mr Khan is the Director of the Science Society and the Radioisotope Centre, Hyderabad He is actively involved in robotics

ROBOTIC REVOLUTION

H. K. Bhattacharyya

A VIRTUAL storm has been sweeping almost all walks of life in the developed countries. The originators of the storm—the robots—are coming in a big way.

Robots are made in all sorts of shapes and sizes, although not typically of human shape Robots have been used primarily in manufacturing. The automobile industry remains a major user of robots not only for hazardous or arduous work like painting and welding but even for screening light bulbs into instrument panels. Robots led the production increase of 20 per cent in General Motors Corporation of U.S.A. The metal industries are heavy users of robots. But robots are used in other manufacturing industries as well. The impact of the robotic revolution may well come in the service industries where employment is growing fast, or in industries which involve professional hazards to the workers.



A Japanese firm had developed a robot to dispose of radioactive wastes at nuclear power plants. The computer controlled robot would soon be put to work, cleaning the reactor and replacing spent fuel rods. This hazardous job usually employs 30 workers for two working days. The robot will be able to perform the same task in a day

The Weseda University of Tokyo has invented the world's first robot musi-

Computer-controlled robotic manipulator

Robot Carpenter

cian, which is capable of playing the electronic organ with its five fingers as skilfully as any gifted human can The robot, Wam-7 has 14 finger joints made of carbon fibre which can strike 10 keys a second. By synchronising the movement of its arm and finger, the robot can strike both black and white keys. The robot can also perform cross-finger piano techniques by moving its index finger or middle finger over its thumb.

Robots are also now used in human care for the handicapped A one-armed robot responds to commands to prepare meals and perform other household activities for elderly crippled people. Speaking at the annual meeting of the U S Association for the Advancement of Science, Mr Larry Leifer of Stanford University, estimated that the robot, when available for routine use would cost no more than an automobile. Mountain View, California, has introduced perhaps the smallest and most dexterous "microrobot", Alpha, costing 10,000 dollars Alpha is capable of stuffing leaflets into pharmaceutical containers, a task so far executed only by people. The Alpha stands 30 cm high and its jointed arm can lift only 0.675 kg. Spine Robotics of Gothenburg, Sweden, have demonstrated the Spine Robot which is able to handle jobs from painting, to welding, to fastening. The Spine Robot has a seventh axial movement which is not commonly found in industrial robots, it's design is similar to the vertebral structure of the human spinal column.

Today, Japan has more sophisticated robots than any other country in the world The Japanese claim of 47,000 robots in 1979, may be an inflated estimate—because the Japanese definition of a robot is much broader than the American one. But even using the American definition, Japan probably has 14,000 robots This is more than the combined total for rest of the world, and approximately 10 times the per capita use in the US. Japanese robots are generally sophisticated and are used in heavy industries. They can perform precision work, but their performance is not limited to a single type of work. They are designed to perform a virtually unlimited variety of tasks.

According to the Australian Financial Review (October, 1981), West Germany had 5,850 robots; the U.S.A. 3,255 (including diecasting robots and pick and place mechanical devices); the U K. 185 (excluding pick and place machines); Poland 720 (including all types), Belgium 20 (excluding the general purpose varieties); Sweden 570 (excluding pick and place, diecasting and general purpose varieties); Norway 200 (including all categories) and Finland 130 (including all categories).

The basic technology of robots is now fairly well known. They are simply mechanical arms which can repeat simple operations guided by a computer. Many robot makers therefore now reckon that the best prospect for growth lie elsewhere. to make robots tailored for their own use. Efforts are being made to develop robots with both sight and 'vision. Robots that can

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FRIENDS" THAT THE FARMER FORGOT

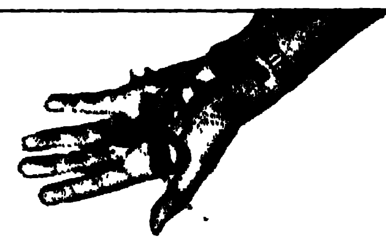
R.K. Robson

IN 1952 the Central Province of Tanganyika (now Tanzania) was experiencing widespread famine. As a Government Medical Officer, I was assigned to the area to take care of starving patients. A very high mortality rate is considered an inevitable part of famine, but my personal intrigue with the phenomenon of famine was not with the numbers of people dying, but with why so many people lived.

The Western concept of famine and famine relief, which was based solely on its ethnic concept of food, helped to explain the high survival rate For example, in Europe food means bread, potatoes, meat, eggs, fish, etc. Shortages of these foods were the basis for designating a famine area; consequently, when the maize crop failed, there was a "food shortage" which was corrected by importing maize to the affected area.

Ethnic biases also prevent the Westerner from recognising indigenous food materials For example, there is a

During a famine in Tanganyika, western experts mistakenly thought the fruit of the baobab (above) tree was the only local food available. Subsequent research identified 40 "bush" foods



Amaranth was once one of the most important food crops of the Americas. But under the repressive programme launched by colonising Spaniards to eradicate the Aztec culture and rituals, the plant was banned with a death penalty for those who cultivated it. It soon fell into disuse and obscurity. Four hundred years later, scientists are rediscovering the myriad virtues of amaranth. Its protein contains nearly twice as much lysine as wheat, three times as much as corn and it is very close to the lysine content of milk, the standard of nutritional excellence.

Amaranth is but one of the hundreds of plants that have received a "raw deal" either because of ill-informed colonial proselyting, plain ignorance or even deliberate neglect of traditional practices. To concentrate on a mere handful of varieties to feed a hungry world is both unwise and dangerous. Plants like amaranth, winged bean, black walnut, the buffalo gourd are among the 54 potential new crops identified by the National Science Foundation for even a developed country like the United States. Indeed, amaranth is among the 36 "most underexploited tropical plants"

Sponsors of research still refused to recognise that indigenous foods could have a potential use in modern society

failure to accept insects as food (while we continue to treat crabs and lobsters as delicacies); wild greens are looked on as the food of cranks, while many roots, seeds, berries and nuts are ignored as food resources. Tanganyika was no exception, and the Ministry of Agriculture, with its Western biases, reported that the only food available in the famine area was Baobab fruit. Subsequent research identified 40 "bush" foods with an additional ten roots eaten in times of famine only.

Ten years later I had concluded that the application of Western methods of agriculture to East Africa was not always suitable or efficient. To relieve food shortages in the Southern Province, improved animal husbandry and agricultural methods had been attempted, but efforts were thwarted by very effective local resistance including the hamstringing of breeding stock. We looked closer at the traditional farming methods to see if this could explain the antipathy.

The Ngoni *shamba* (garden or field) is characterised as a "shambles" by Western Agriculturalists, in whose eyes the food was grown in a chaotic (and therefore inefficient) way. The system nevertheless seems to have many advantages. For example, when the maize and beans were planted together, the stalk provided a useful climbing medium for the bean while the bean fixed nitrogen in the soil which helped the maize to grow. These two plants provided shade in which tomatoes and "non foods" such as amaranth could grow.

The Westerner's method was to plant maize in neat rows in one field (preferably with fertilizer). The bean was grown elsewhere, but as some varieties were climbing plants, poles had to be provided. Tomatoes and exotic vegetables such as lettuce had to be watered and shaded While the Western methods were believed, but not proven, to be more productive, there seemed a need to examine the potential of local food plants and native horticulture.

Over the next 20 years, although constantly frustrated by lack of money, and open hostility from conventional agriculturists and government departments, the programme has shown that these indigenous foods can contribute to food supplies, but clearly much more needs to be done if world-wide hunger is to be avoided.

In our Indigenous Food Program, a search of the scientific literature was started for information on food plants which have been used by man in the past. This is far from easy, as we were interested in populations living before 10,000 B.C. Around this time, the agricultural evolution started and early man learned to domesticate the grasses which are now known as cereal grains. This specialisation in agriculture meant that there was insufficient time for gathering the wild plants that had been part of the diet previously; consequently, many fell into disuse. The archaeological literature provided descriptions of food remains found in caves and around camp sites, and it is apparent that hundreds of plants were exploited and that some had considerable importance in the diet. Supportive evidence of this comes from studies of aborigines in Australia, the Kalahari desert, the Phillipines, India and South America who still follow the Stone Age mode of life. These studies have confirmed the complexity of the diet and the importance of plant foods, and they also helped to identify certain foods which have had, and continue to have, great nutritional importance. For example, the flesh and kernel of the Mongongo nut provides about half of the total energy requirement of the Kalahari San Bushmen.

Once the different and varied food resources have been described, it is then necessary to ascertain their nutritive value which implies knowing how the foods were prepared and cooked. Over the years a mass of information has accumulated and can be found in published literature and unpublished reports in libraries around the world. When the information on the nutritional content of foods is needed, however, major difficulties become evident. The Western World has generated food composition tables, but mostly they provide information on the foods of the industrialised nations. Data on indigenous foods is sparse and gives little information on the nutritive value of foods *as consumed*. Even when information is available, some foods have been ignored because of problems observed in the nutritional content of raw foods. For example, acorns which were an important food item in the diet of early man in the Midwest of America are considered inedible because they contain tannins which are bitter. It is overlooked, however, that early man found successful ways of eliminating the bitter components.

The use of the wild Camas bulbs as a starchy staple by American Flathead Indians provides a classic example of missed opportunities due to ethnocentricity. The Camas bulb was scorned because the carbohydrate in the raw plant consisted of inulin, an indigestible substance. When we analysed Camas bulbs as cooked by the Flathead Indians, the carbohydrate was found to be fructose, a highly assimilable carbohydrate. It is interesting to note that Western scientists can bring about the conversion of inulin to fructose by the process of acid hydrolysis. It had never occurred to nutritionists that this process had been discovered centuries previously. The Flathead Indians had learned to replicate the acid hydrolysis by the simple process of cooking the bulbs on hot stones covered by leaves and moist earth. The indigenous preparation is a classic example of how neglected or ignored foods might be exploited.

During our early work, it became obvious that we needed to collate data obtained by scientists in anthropology, history, agriculture, chemistry and biochemistry. This synthesising type of thinking was diametrically opposite to the intellectual processes prevalent at that time when it was believed that proper understanding was to be reached only through more and more detailed analysis of facts. The established devotion to specialisation was a subsequent major stumbling block to

our work when we sought financial support.

Despite the rejection of our ideas, we persevered and began to recognise that seemingly unimportant dietary components made from indigenous plant foods were nutritionally significant. In New Guinea, the Sago palm leaf is burned to produce an ash which is then used as a condiment. In the laboratory it was found that the ash contained sodium, potassium, calcium, magnesium, iron and phosphates. One of the more intriguing features of the ash was the discovery that it was highly alkaline. As the diet of the local inhabitants tended towards acidity, the body would normally have to produce ammonia to neutralise the acid. The ammonia and its nitrogen would then be lost in the urine. By ingesting the Sago ash, the body did not have to produce ammonia, thereby saving protein and helping to explain why Papuans can exist on very low protein intakes.

Although a formidable amount of convincing data relating to the availability, composition and use of indigenous foods was generated, the sponsors of research still refused to recognise that indigenous foods could have a potential use in modern society. The development of amaranth as a food crop illustrates the difficulties and frustrations which had to be faced.

During our preliminary search of the scientific literature, we decided that out of hundreds of plant foods, ten were worthy of immediate study. All of the plants selected were classified as weeds: the plant most favoured for potential was amaranth (pigweed). The association of these plants with the word "weed" was unfortunate and the cause of much resistance. Weeds imply nuisance and, because they are so botanically successful, they are often a threat to conventional food crops and hence disliked by conventional agriculturalists. With respect to amaranth, another unsuspected historical deterrent was found.

During the era of the Aztecs, amaranth was such a successful food crop, it was figuratively and literally idolised. Pagan worship of the plant was abhorrent to the Spanish Conquistadors who colonised Central America, and the growing and consumption of amaranth was forbidden under punishment by death. Eventually, Cortez brought about the effective elimination of amaranth as a major food crop in Mexico. Over 400 years later when our team was looking for samples of seeds in Mexico, there was still reluctance on the part of some local inhabitants to admit they were involved in producing amaranth.

In the meantime, our research had shown that amaranth was a unique plant in several respects. Its ability to adapt to a variety of soils, light intensity, rainfall and altitude meant that it was found in many countries with differing botanical names. Some varieties yielded massive amounts of grain; others appeared to specialise in producing leaves. The help of botanists and ethnobotanists was sought to define the taxonomy of the plant. We increasingly recognised the potential of amaranth as a food crop in developing countries, as we had evidence of its contemporary cultivation in South America, Africa, Europe, India, South East Asia and the Far East. The global availability of amaranth suggested to us that it had been a significant food crop in the past; therefore, we argued it could make a contribution to global food supplies once more. This argument was also not acceptable to contemporary policy makers.

Despite this, we continued to fill in

The Amazing Amaranth

AMARANTHUS includes about 60 species of annual herbs distributed in the tropics, of which 25 occur in our country. A few such as *A. gangeticus (chaulai sag)* are cultivated as pot-herbs. Two other popular species. *A. caudatus* and *A. paniculatus*, are grown as grain crops. The grains are popularly known as *Rasgira*, *Tandulja* or *Ramdana*. Almost every species of this genus is eaten by cattle as well as humans. In many places in India this is the only vegetable that our rural folk and tribals consume. Some of these valuable plants are regarded as weeds. *A. spinosus* or Kantemath for example. Boiled with pulses it makes an excellent health food for undernourished children and nursing mothers. The plant known as chaulai *(A. paniculatus)* is a valuable crop in the hilly tracts of Southern Asia—popular in India, Sri Lanka, Burma, Western China, Thailand and Philippines. In our country the plant is raised as a rabi crop and is harvested during February-March. The tender shoots and leaves are used as vegetable. The seeds furnish *anardana*, a food grain used by the poor. Actually the rich do not know what they are missing out on: "Amaranth is indeed a nutritional treasure," says Noel D. Vietmeyer, in the Britannica Yearbook of Science and the Future (1983). At a rating of 75 it comes closer than any grain to the perfect balance of essential amino acids, which theoretically would score 100 on the nutritionists' scale of protein quality. By contrast corn scores about 44, wheat 60, soybean 68, and cow's milk 72. When Amaranth flour is mixed with wheat flour, the combination almost reaches the perfect 100 score because the amino acids that each lacks are abundant in the other.

Not only the seeds are nutritious. Amaranth leaves also are rich in protein, as well as in vitamins and minerals. They have a mild flavor and can be cooked much like spinach into such dishes as amaranth au gratin and amaranth quiche. In addition, tender new leaves may be used as salad greens.

Despite the growing wealth of evidence for amaranth's excellence much research needs to be done before the crop can be widely grown commercially. Amaranth is still essentially a protein-packed semi-domesticated plant, but agronomists are now "taming" it by breeding plants of uniform height with sturdy wind-resistant stalks and high-yielding seedheads that hold onto their seed until they are harvested. The responses of these plants to a variety of climates, soil conditions, pests, and diseases are also under investigation.

Sudhir Ghatnekar

the gaps in our nutritional knowledge of the plant and to ascertain which varieties had the greatest horticultural or agricultural potential. While the protein, fat and carbohydrate content of the plant were known from previous proximate analyses of the grain, we needed to know more about the value of the protein by analysing the amino acids in the grain. Animal feeding experiments were also proposed to confirm the ability of the grain to maintain health and support human growth. It was possible that some varieties would have nutritional advantages while others would have agricultural advantages. With such a potential gold mine available for exploitation, it was not envisaged that overt resistance to the appeals for financial support for the amaranth project would be encountered.

This, unfortunately, proved to be the case; and as time passed and as a succession of government agencies discouraged our work and plans, additional attempts were made to interest Foundations in our project with an equal lack of success. In desperation, Mr. Robert Rodale of Rodale Press was approached. He had the vision to see the potential value of amaranth and within a matter of weeks, a project for the world-wide collection of seed grains and for the testing of the nutritional value and horticultural and agricultural potential of amaranth was started.

The success of this project is unquestioned, and the future for amaranth as a food crop looks good; but it should be remembered that the other nine food plants remain untested, and these represent only a small proportion of foods already available to feed man. There is surely sufficient information to justify large-scale research on the potential of indigenous food plants. Perhaps the problem lies not so much in the simplicity of the concept of using indigenous plants and agricultural methods, but the complexity of the scientific world which seems determined to deter progress. The amaranth project involved dozens of scientists from different disciplines, yet their efforts were meaningless until a human catalyst appeared. The need for more catalysts is as patently obvious as the great potential of indigenous foods for global food resources. □

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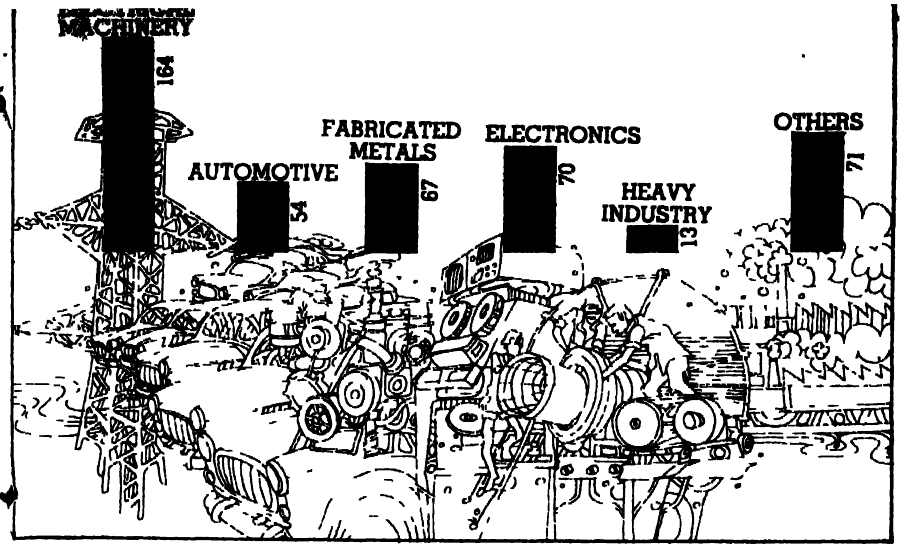
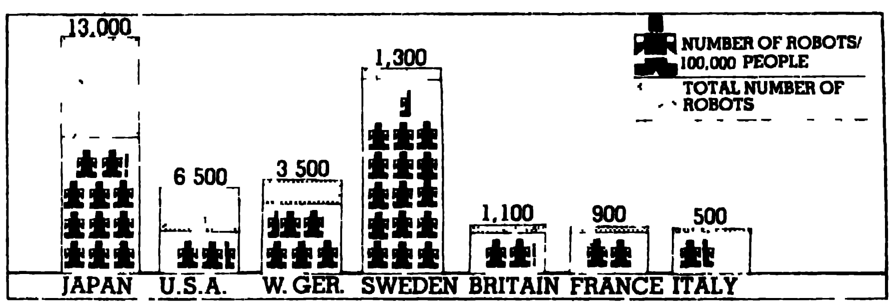
Fruits **of Parkia speciosa (above) are valued *as food in Thailand*; Below right: *Pygmies have survived for centuries on indigenous food sources*; Below left: Papua *New Guineans processing sago***



Estimated (1985) industrial expenditure on Robots in the U.S. (million dollars)



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understand simple spoken commands are also being developed. It is now possible to create a robot with multiple arms. Even roboticists cannot foresee all the possible future applications of robots.

The British Robotic Systems has developed a "second generation" robot, Autoview, whose movements depend on what it can "see" through its electronic eyes. Conferring vision on a robot is believed to be a step towards replacing the human eye for industrial tasks. The robot's visual system which works in black and white can distinguish 256 shades of grey and it comes close to achieving three dimensions in analysing light intensities. The vision control equipment identifies different metal castings by their shape, then orients them to within half a degree and loads them into a machine tool in 30 seconds as compared to 90 minutes for an experimental American system. Autoview is used for the inspection of products including car parts, pharmaceuticals, and even cakes. It blindly performs a series of repetitive tasks like painting, spraying and spot welding.

History shows that labour saving techniques have led to improved living standards. higher real wages and employment growth. The robotics revolution is merely a continuation of a century old trend that has resulted in enormous material progress. The robots can produce qualitative as well as quantitative improvements in goods and services. Robots, in dangerous and hazardous work situations will improve the working conditions and job safety in certain occupations. New forms of employment can be created to offset any job lost directly due to the usage of robots. However, Nobel laureate, Wassily Leontief, Director, Institute for Economic Analysis, University of New York, foresees mass joblessness. "The computer and the robot are already beginning to replace the simpler mental functions of the blue and white collar worker". However, views and opinions diverge widely.

In less than 10 years, unmanned automatic factories have become practical propositions. The owners of factories and plants are under irresistible temptation to replace their skilled labour by robots. These machines have certain advantages over men and women. They never go on strike, never get fatigued, neither do they become ill nor do they require sick leave or maternity leave. Above all, they do not demand wage increase or bonus even if the company is running at a loss. The new technologies can provide a company with a massive cut in production costs and at the same time give a binding promise of superior and never faltering quality.

The automatic factory would be based on a computer controlled system feeding customers' orders directly to start the manufacturing process. Raw materials and parts would be ordered automatically from the stores and delivered by driverless trucks. Robots would pick up the goods, feed them to conveyors, initiate the operating process, transfer the goods from one place to another, service the computer machine tools, inspect and monitor the quality of the products and finally package and dispatch them—all with unwavering precision.

The robotic revolution will depend upon three important dimensions. First of all, the magnitude of growth of the robotics industry. Secondly, the impact of robots on unemployment and thirdly, the impact of robots on wages, profits and prices. An increase in the use of robots will depend primarily on supply and demand. On the demand side, robots will be needed in qualitative and quantitative jobs requiring high precision and also those jobs which are dangerous for human operations. On the supply side, the cost per unit robot produced output will be lower than for traditional techniques of production. In the long run, however, robots will be increasingly used because of their cost competitiveness. Robots will probably replace workers who are engaged in monotonous tasks. The initial impact of robot installation will be reduced employment and under-employment. But jobs will be created by the widespread use of robots. These will include increased opportunities for programmers, engineers and technicians, thus providing greater employment albeit in a new sphere.

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TETANUS: for a rusty nail, a life is lost.

ILLUSTRATION BY FRANCIS HUSA

THE LAST patient had just left that evening. I was about to leave my rooms when the telephone rang.

I am Sanjay's father speaking. The tone was aggressive.

Yes. And how is Sanjay? I asked anxiously.

Sanjay is dead, was the reply, and before I could offer any word of sympathy he shouted, *and you doctors helped to kill him.* The line was cut off.

Two weeks later he came to see me, still grief stricken but the anger was gone.

I still don't understand what happened, and I need to know, he said. We went over the whole story.

Sanjay, his only son, was a cheerful five-year old boy who while playing at school one morning had fallen and grazed his right leg badly. Dirt and grit had got into the wound but it had bled only briefly. Sanjay had tied a handkerchief around his leg and without making any fuss had gone back to his class after break. That evening his mother washed the wound with soap and water but could not remove all the dirt. Next morning, she took Sanjay to the doctor who applied some antiseptic locally but told Sanjay's mother that he advised a special injection to prevent any chance of tetanus. Sanjay hated injections, but he went ahead and took it.

The whole incident was almost forgotten when after four days Sanjay noticed some difficulty in opening his mouth. Later that day, it got worse: he could not chew his food properly and his speech became indistinct. His mother became alarmed when her neighbour told her that Sanjay had lockjaw, the first sign of tetanus. She took him again to the doctor insisting this time on a second opinion.

That was when I first saw Sanjay. By now he was obviously stiff when he walked and found it difficult to sit up from the lying down position. The presence of lockjaw and other signs all suggested the diagnosis of tetanus. I admitted him into a hospital as the disease appeared to be progressing fast. By the following morning, all his muscles were in a state of contraction and violent tetanic spasms had begun to rack his body. He could not swallow or cough, and worse still he could not breathe whenever a spasm occurred. A tube was put into his wind pipe to overcome this problem and powerful drugs administered in an effort to control the spasms. But it was all to no avail. The heightened excitability of his nerve cells brought about by tetanus toxin made them exquisitely sensitive to any stimulus. The spasms increased in frequency and severity and he died 72 hours after the appearance of first symptom.

Cutting the umbilical cord with a dirty instrument, can clip a promising life in the bud—through tetanus

Sanjay's father gazed steadily at me seeking some explanation and blurted, *"But why Sanjay?"*

Tetanus germs you must understand are found worldwide. They exist in the soil, in dirt and dust as spores, and are found particularly in areas heavily polluted with animal excreta. This means that all of us will harbour tetanus spores on our persons from time to time.

But all of us don't get tetanus.

That's true. Spores are harmless unless they get into the body through a break in the skin. Even then they need rather precise conditions for their further growth into bacteria. It is the bacterium you see, that secretes the lethal toxin. The precise conditions I mentioned, refer to an atmosphere free of oxygen.

But I thought all living things required oxygen to grow.

No, not tetanus spores. In fact, it is important to know about the nature of injuries likely to lead to tetanus. These are puncture wounds, with say a wooden splinter, a glass piece, or a rusty nail, which form a special hazard for people who habitually walk barefoot in the open. Burns and open fractures are also dangerous, since here the skin barrier is broken, and dead tissue is present in which any inoculated tetanus spores may grow and produce toxin. Surprisingly, however, most injuries that cause tetanus are trivial in nature, rather like the one sustained by Sanjay.

What should be done to make such injuries safe, then?

Thorough cleaning helps to remove teta-

nus spores and allows vital oxygen into the wound, thus rendering any remaining spores harmless. But here two things are crucial. If wound-cleaning is delayed by more than eight hours or is performed inadequately, then tetanus spores have time to germinate into bacteria and produce toxin. Remember, Sanjay's wound was difficult to clean completely.

Yes, I know. But our doctor gave a special injection to prevent tetanus. Why didn't it work for heaven's sake? It must have been the wrong injection!

Not exactly. Look, tetanus is preventable by immunisation and it has been so for the past 50 years. Since it is the toxin that kills, the vaccine used contains tetanus toxoid. This is a chemically modified form of toxin which is harmless to the body but which is still immunogenic, that is, it stimulates the body's immune system to produce antibodies against the toxin. Antibodies provide immunity if present in a high enough concentration.

Since tetanus may occur at any time of life, the standard practice is to immunise infants with three doses of triple vaccine. Triple vaccine, incorporates diphtheria, pertussis (whooping cough) and tetanus vaccines into one injection. The antibody produced by three such injections protects the child against tetanus for five years. However, to make sure that protection is maintained, a booster dose of tetanus toxoid is usually given at school entry and thereafter at five yearly intervals. Did Sanjay get his tetanus shots as a baby?

Now that you mention it, he did not. We took him to the doctor alright, but he had a skin rash at the time, so we were advised to postpone immunisation. After that, somehow we forgot all about it.

That means that when your doctor gave Sanjay the special tetanus toxoid booster injection, he had in fact no antibody in his system to boost. For this reason it was ineffective. Your mistake was that you had not had Sanjay immunised against tetanus, and the doctor's mistake was that he did not check this fact.

What could he have done had he known the real situation?

He should have given an injection containing preformed antibodies. Such antibodies are prepared by immunising horses with tetanus toxoid and then extracting the tetanus antibodies from their serum. Such preformed antibodies, however, are only effective for two to three weeks and because they come from animals, there is always a chance of allergic reactions to any foreign

Even minor injuries, if not cleaned immediately, can act as entry ports for tetanus spores

protein contained in the injected serum. In recent years, human tetanus antibody which is safer has become commercially available, but it is expensive.

I don't see why this passive immunisation cannot be given to everyone after an injury.

Repeated injections of passive antibody make it less effective and the person may become more allergic. Furthermore, there is no certainty that people will seek the injection when it is really needed. That is why active immunisation with tetanus toxoid, where you form your own long-lasting antibodies, is far superior.

So Sanjay's life could have been saved if only we had known these simple facts.

Yes, I think so.

Is tetanus infectious? Are any of my other family members at risk because of Sanjay's illness?

No. Tetanus is not infectious, in the common sense of the term. By that, I mean you cannot develop the disease, say, by visiting a tetanus patient in hospital. But, at the same time that same tetanus patient cannot have his wounds dressed in the hospital operating theatre, since his tetanus spores might contaminate the operative site of the next patient brought into theatre. But you must get your family immunised after this terrible tragedy.

Yes, of course. But, doctor, what about newborn babies who die of tetanus? There is no wound in those cases, surely?

That's true, and in fact this is the most tragic form of the disease. It occurs in the newborns because the umbilical cord connecting the mother to her baby is cut with an instrument harbouring tetanus spores. Rust or dirt on knives, blades or sickles or even a piece of sharp glass, all of which are often used to cut the cord, may contain tetanus spores which then enter the baby. Sometimes, cowdung or slate powder containing tetanus spores is applied to the baby's navel when the cord shrivels and is about to fall off. This also may lead to tetanus. In India 100,000 babies die of tetanus every year. Simple precautions could literally save thousands of lives.

How terrible. I never realised that the problem was so big. Are there any other ways that one can get tetanus?

Yes. Children commonly develop ear infections which lead to a discharge from the ear. Adults are prone to blockage of the ear drums with wax. In both situations, there is a temptation to introduce a wire piece, match stick, or similar agent into the ear. Such agents can carry tetanus spores. Then again women get tetanus if spores enter the genital tract at the time of child birth or during any gynaecological operation. Unsterile instruments are responsible for this which is why criminal abortions and procedures done by quacks are likely to end in disaster.

What's the answer to this whole problem?

Immunisation and more immunisation! In all countries where the population is actively immunised against tetanus from birth and receives appropriate booster doses throughout life, the incidence of tetanus has reduced dramatically. In our country we have the vaccine, but alas, not the cooperation of our people for the necessary immunisation schedule which requires three doses at spaced intervals to give protection.

Things would be so much easier if we had a tetanus vaccine which could give protection with a single dose, even if this was for a limited period, say five years. In fact, progress towards this end is being made in India at the moment. If successful, we may in future have a situation similar to that which existed for smallpox a decade ago, where vaccination successfully eradicated the disease. With tetanus, a single dose vaccine given to all pregnant women could help eliminate the scandalous loss of life presently due to newborn tetanus.

Meanwhile, it is the responsibility of we educated Indians, to see that our children complete the immunisation schedules against all diseases included in the Government's expanded programme of immunisation which includes protection against whooping cough, diphtheria, tetanus, poliomyelitis, measles, and tuberculosis.

Faram D Dastur

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The art and culture of the megalithic man

This comparatively less known culture has a distinct place in Indian protohistory

S. B. Deo

This terracotta lid with a ram motif on top is a megalithic relic recovered from a site in Mahurjhari in Maharashtra

They are found in a variety of forms—a single stone staring at the sky or a series of them, a circle of stones or a bunch of capped stones, or caves cut in rocks. To the unwary, these may not mean much but to the archaeologist, they tell a distinct story of an ancient culture, the megalithic men who marked the burials of their dead with large stones. And buried beneath these stones may be an archaeological treasure, dating back to as early as the 10th century BC, and containing, besides the skeleton maybe, a bewildering range of pottery and metal tools and artifacts which the megalithic men interred with their dead. Such sites have been found throughout India, more so in South India, in the last century and a half.

It was in 1823 that J. Babington first wrote of such distinctive burials that he found in the Malabar region (in the present Kerala state) Local tradition assigned these to the Pandavas of the *Mahabharata* and called them *Pandukkulis;* in other regions, other legends abound. Though thousands of such monuments found and a score of them excavated and studied since then have provided enormous information, there are still large gaps in our knowledge about the megalithic culture. And despite its distinct place in archaeology, the megalithic culture is less known than other periods in Indian protohistory.

But a few new facts have emerged from these recent studies. The origin of the megalithic culture, earlier placed around 2nd to 3rd century BC, has now been pushed (based on carbon-14 dat-

ing) to as far back as 10th century BC; in peninsular India, the culture seemed to have survived to the first couple of centuries of the Christian era. Some of the megalithic sites in this region had yielded coins of the Roman emperors Tiberius and Augustus and a Roman coulter of iron belonging to this period. Indeed megalithism in some form is still in vogue among the tribes in the Nilgiris (in Tamil Nadu), Bastar (in Madhya Pradesh), in Orissa and Nagaland.

Earlier it was also thought that the megalithic people were nomadic and not much of artistry or technological excellence could be expected of them. But the range of objects found at the burials testify to the technology and the art and culture of these people. It is now beyond any doubt that these people were master craftsmen.

But first, what is a megalith? The word itself is derived from *megathos* meaning large and *lithoi* meaning stone. In a facile definition, megalith would thus mean a large or a big stone. Not all big stones, however, are megaliths in the archaeological sense; nor are all megaliths necessarily big stones. A megalith is essentially a funerary monument and it differs from region to region.

The forms indeed show quite a range—for instance, a cairn (stone circle), a menhir (a single stone) or alignments (a series of stones), a dolmen, a cist, a dolmenoid cist, a rock-cut cave, a chambered tomb or a topical (some of these are shown on this page). All these are basically connected with human burial, though

Megalithic burials are found in various forms—for example, (1) a cairn circle or a circle of stones, (2) a menhir or a monolithic pillar, ranging from a metre to 5 metres in height, planted vertically into the ground more as a memorial, (3) an alignment, or a series of menhirs placed in rows, (4) a rock-cut cave, (5) a dolmenoid cist, a rectangular or box-like arrangement of stones capped with a stone or stones, (6) a dolmenoid cist after excavation. (Photographs 2 to 6 are from **The Megalithic Culture in South India** *by B. K. Gururaja Rao)*

A pot with painting in dull white from Coimbatore district, Tamil Nadu

only partially in several cases. Sometimes, some of the monuments, for instance, the menhir, are more of memorials than markers of actual burials. The type of megalith found in the Vidarbha region of Maharashtra is the cairn circle, which means large boulders placed in a circle. Within this circle were placed the remains of the dead along with a host of artifacts of iron, copper, bronze, gold and electrum (an alloy of silver and gold used by the ancients). Sometimes, a horse, probably sacrificed with the dead, was also buried with all its trappings and ornaments.

The buried objects too range widely. They included a distinctive pottery, known as Black-and-Red (burnished black inside and red on the external bottom), burnished black, dull red, micaceous red and sometimes painted pottery. The iron objects consisted of agricultural implements like ploughshares and hoes, carpentry tools like chisels, and things of daily use like knives, frying pans and nail-parers, and offensive weapons like swords, daggers, tridents and lances. Among copper-bronze articles were solid bangles, dishes and lids, the latter sometimes topped with delightful finials like buds, or birds and animals; some objects were of two metals, for instance, daggers with a copper hilt and an iron blade. There were gold ornaments like diadems, ear-rings, and studs, cabled wire necklaces, and beads of semi-precious stones like agate and carnelian, some with designs etched on them. And where horses were buried with the dead, ornaments meant for their face and flanks, made out of copper-bronze sheets, are found among the burials, in several cases, these show the use of a composite technology, for instance, copper bells with iron clapper or copper sheet roundels rivetted to base with iron pins.

All these objects were buried with the dead possibly with the view that they should be of help to the person in the 'afterlife'. But the objects also reflected the social and economic status of the dead. More important, the fact that so many objects were interred

Terracotta figures from the Nilgiri area in Tamil Nadu a male (right), a horserider (below) with the torso cut, and a female (below, right). (Photographs on this page and the hut model on the next page are from **South Indian Megalithic Burials** *by Lawrence Leshnik)*

A hut model in clay from the Coimbatore region in Tamil Nadu (above)

Iron knives from Maharashtra (right)

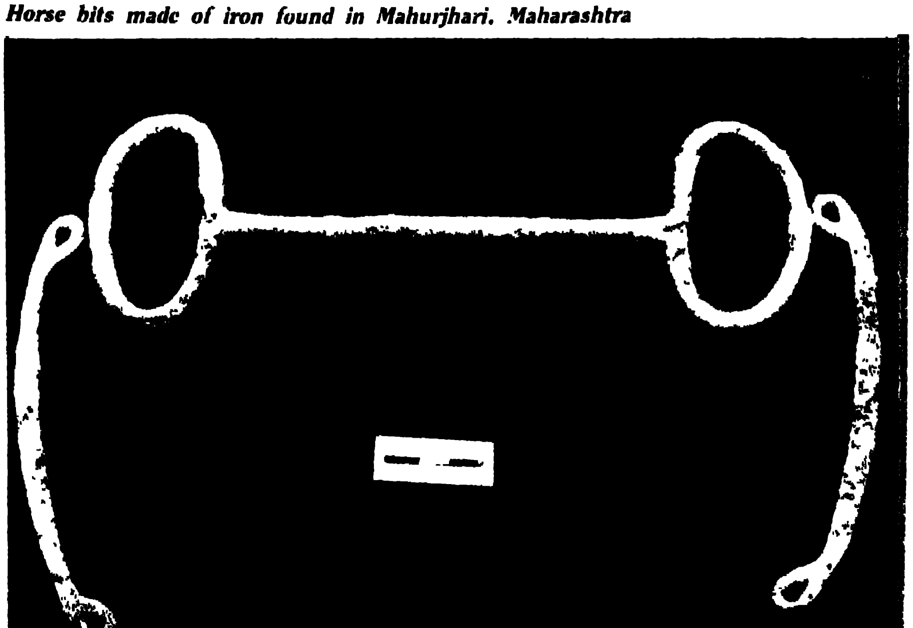
with the dead also implied that there must have been, within the megalithic community, a permanent class of artisans maintained out of the agricultural surplus produced by the use of a range of agricultural tools. There has been evidence in megalithic sites of a largescale domestication of animals, and grains like rice, barley, millets and black gram have actually been recovered.

No other contemporary culture had produced such a level of technology as produced by the megalithic artisans. Though iron (the megalithic is essentially an Iron Age culture) has also been associated in North India with what is called the Painted Grey Ware culture, which many date to the beginning of the first millennium BC, the amount of iron objects associated with this culture is far less than that found in the megalithic sites in South India. Moreover, iron-smelting furnaces recovered at megalithic sites have shown the iron technology they used.

As mentioned earlier, the artistic and technological talent of the megalithic people is reflected in a variety of artifacts which they turned out. Even in ceramics, they made a distinctive contribution. For instance, besides other wares, the unmistakable ceramic trait of the megalithic culture of peninsular India is the Black-and-Red pottery, distinguished both in typology and technology. It is a thin ware with highly burnished surfaces (due possibly to salt-glazing according to some scholars), entirely black inside and red on the external bottom (due to inverted firing according to some) and thrown on the wheel. The megalithians turned out exotic shapes like bowls with elongated tapering base, squat pottery stands, lids with ornamental heads, the latter sometimes embellished by motifs like that of a ram or four birds or buds. They also used pottery painted black on a red surface or yellowish cream on a red surface. The artist's skill is displayed in the regularity of the painted lines and the masterly control on line work (see picture on p. 30).

The megalithic people also excelled in making terracotta figurines and models. Though associated with the later megalithians, the terracottas from the Nilgiri area are distinctive. Entirely hand-fashioned, they have a primitive tribal charm. The female figure is shown wearing a number of bangles on her left hand, the necklace is shown by punctured dots, and possibly also a bodice and a torque (see p. 30). The punctures on the face indicate tattoo marks, the hair is bunched in a chignon on her head. She has round punctured eyes, slit mouth and a broad prominent nose. She could as well be a cult figurine. The male figurine, on the other hand, has legs wide apart; possibly the figure was mounted on some animal. It has a slit, wide mouth, outsize eyes, pinched nose and prominent eyebrows. It appears to wear a decorated or embroidered apparel indicated by short linear incisions. Though primitive in appearance, it depicts the skill of the artist so far as the proportion and slimness of the figure is concerned and can be assigned to the first couple of centuries of the Christian era on stylistic grounds. That such figures were mounted on some animal is substantiated by another specimen, again from the Nilgiri hills which shows a human figure riding possibly a horse (see figure). Unfortunately the

Horse bits made of iron found in Mahurjhari, Maharashtra



upper half of the human figure is broken, but it seems to wear some ankle-reaching garment indicated by incisions. It also wears an ornament around the ankle. The horse is shown quite realistically with a long neck, short ears, cross-eyes, open mouth and a short tail. It is remarkably modelled in the round and can be assigned to the same period as the specimen referred to earlier. Both these are blotchy red and do not seem to have been adequately fired.

The human figurines could possibly be cult objects. That cult objects, if at all they are, played an important part in the life of the megalithic people is further attested by what could be termed as models in clay of a hut. One such specimen has been recovered from the Coimbatore region (see p. 31). It is made from a coarse type of clay and fired in reducing conditions resulting in the hut-model appearing black. It shows a circular hut with conical roof, short walls and a rectangular opening for entrance. The whole hut is on a stand base. The modelling is perfect and precise. Tribals in that region still build circular huts. Evidence of circular huts of the megalithic people, datable on carbon-14 analysis, to 7th century BC has also come to light in the excavations at Naikund in the Vidarbha region of Maharashtra

It is, however, in the field of iron technology that the megalithic people excelled. Their burials are rich in the variety of iron objects. A fair number of these are tools of offence like daggers, swords, tridents, lances, spears and arrowheads. A large number of every day utilities of iron are also interred—cauldrons with flat base and side handles, a large variety of chisels, nail-parers with cabled body and sharp bevelled working ends, adzes, axes and agricultural tools like hoes and sickles. In some cases, the horse with all its trappings was also buried with the dead, and horse bits of iron (see figure) have also been reported from several megaliths; three varieties of these are known: snaffle bits, barbed bits with looped ends and barbed bits with

A copper pot with parts joined by iron rivets

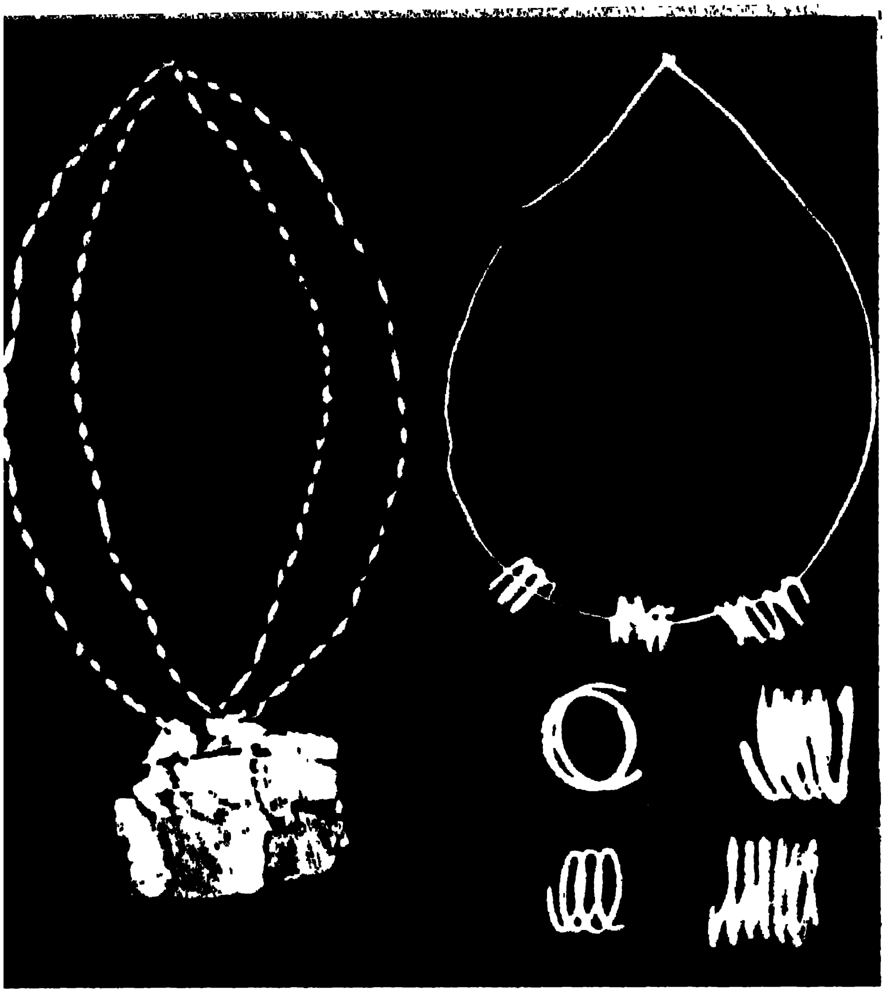
looped nose and mouth piece. These show the close association of the horse with the megalithic people.

These iron artifacts show a very high percentage of iron, as high as 99.6 per cent. The Mahurjhari specimens (Nagpur district in Maharashtra) show 99.1 per cent iron and 0.9 per cent carbon. The addition of carbon strengthens iron. Recently remains of an iron-smelting furnace have been recovered at Naikund in Maharashtra. The furnace, circular on plan, was built of clay bricks of an average thickness of four cms. The furnace was 30 cm in diameter and 25 cm high. The bricks were interlocked in tiers. Along with it, two tuyeres made of clay as also abundant iron slag were found. Dr. Gogte, of the Deccan College, Pune, had worked out that the megalithic smelters (of Naikund) used 10 to 12 kg iron ore in a single smelting operation, producing 3 to 3.2 kg of pure iron. An analysis of the iron ore found nearby the furnace confirmed that the megalithic smiths of Naikund used local iron ore. Curiously the iron objects interred with the dead show minimum rusting.

A copper lid with bird finials

Along with iron objects, the megalithic people seem to have been adept in the use of copper-bronze as well. A large number as well as variety of copper-bronze objects have been found in the burials as well as habitational deposits. These again include articles of everyday use, for instance, pots and pans, bangles, lids, bells for animals, and ornaments for the horse. A notable feature is that some of these contain a high percentage of tin For instance, bronze cups from Raigir in Andhra contain 21 per cent tin whereas bowls from the Nilgiri megaliths have 28.89 per cent tin. On the other hand, sites like Mahurjhari and Takalghat in Maharashtra show a high percentage of copper (87 per cent) and only traces of tin. What is surprising is that in spite of the well-known paucity of copper in India, the megalithic people seem to have used copper-bronze on a large scale and further that they could afford to bury such objects with the dead.

Some of the copper-bronze objects



Gold necklaces and spiral ear-ornaments (bottom) from Mahurjhari, Maharashtra

show a remarkable mastery over copper technology as well as artistic talent. These objects are generally of egg-shell thin sheets of copper. Perhaps the best specimen of the coppersmith's skill comes from Mahurjhari—an egg-shell thin sheet of copper cut to the shape of the front of a horse's face, and fixed over this sheet are copper sheet roundels with iron pins. On the periphery of this ornament are round perforations which suggest that the piece was mounted on a leather base and then placed on the face of the horse. Yet another specimen of excellent technology comes from the same site, a pot with a round belly and a high neck, fashioned in three separate pieces—the bottom, the shoulder and the neck—which have been rivetted to each other by circular iron rivets; the rivets are so fixed as to appear one with the body and the whole piece is extremely symmetrical and faultless in outline. No such piece has been reported from any other site in India. This excellence in craftsmanship is also displayed in some exotic objects like lid-heads with motifs of four birds or of a cock or a dog or of a group of buds. Such lid-heads were made separately and then mounted on top of a tapering lid or cover. Adichanallur in Thirunelveli district in Tamil Nadu has reported a number of these. Apart from the artistic merit of such pieces, it is possible that these exotic objects were meant for special rituals.

That the megalithians were adept in composite technology is attested by some specimens which use copper and iron in the same artifact —daggers with copper hilt and iron blade reported from Mahurjhari (Maharashtra) and Pochampad in Andhra Pradesh. Besides such daggers, these smiths also produced copper bells with domical body and iron clapper

Such mastery is shown in making objects of gold and electrum also A variety of gold objects from diadems to small beads have been reported from megalithic sites in India. The exquisitely decorated diadems reported from Adichanallur are well-known Paiyampalli in Karnataka has given a goldsmith's stone mould. The megalithic goldsmiths were so adept in the execution of gold ornaments that they could prepare cabled wires, wires as thin as one millimetre in thickness, spiral ear-ornaments, decorative motifs in repousse, thin disc-beads and wire necklaces whose ends could be interlocked. The megalithic people were also expert bead-makers for which they used semi-precious stones like agate, carnelian, chalcedony as also other materials like shell, bone, glass and terracotta. They knew the art of etched beads, that is, etching decorative motifs in black or white on agate and carnelian beads. Some of the etched designs are typical of the megalithic culture and have been reported from a number of megalithic sites in peninsular India.

The arts and crafts of the megalithic people in India have earned a special place in the history of technology and artistic traditions. Yet there was a time when these people were taken to be nomadic. Recent researches have proved that they led a relatively settled life, practised agriculture, maintained a highly skilled class of artisans and practised a distinctive burial ritual. Surviving for well over a millenium (c. 1000 BC to 2nd century AD), they have left enough material evidence of their distinct artistic and technological talent.

Who were the megalithic people? No final answer is yet available. In several places that were excavated, the burial was only fractional, and in other cases skeletal evidence was found only in a smashed state because of the fillings above. Consequently, physical anthropologists have so far been able to study only a few skulls, and these have led to divergent views. Some earlier views assigned the megaliths to Druids (belonging to the pre-Roman inhabitants of north-western Europe or ancient Gauls and Britons), Celtic or the Scythian people Others say they were Dravidians, and some think they were Mediterraneans. Some even argue that the megalithic people came to peninsular India via the sea while some trace them to West and Central Asia.

Prof Deo is Director of the Post Graduate and Research Institute, Deccan College, Pune.

SCIENCE CITY

I AGREE with Prof. Udgaonkar's idea of creating a number of small advance science/technology centres, instead of creating a separate independent Science/Technology City. Existing industries, technical institutions and universities may provide at least a part of infrastructure needed for such a development. Suitable locations for these centres can be chosen, depending on the nature of projects.

These centres can have the latest science/technology projects, sponsored by Indian scientists or expatriate scientists. Help to all good projects should be provided on the basis of equality. No attempts should be made to create further differences between two equally qualified persons sponsoring these projects. This step will eliminate at least one reason behind the brain drain.

Cooperation between the Indian scientists/technologists and the know-how available with emigre scientists/technologists is also desirable. Both are products of Indian institutions, and perhaps they can promote some suitable common fields of interest financially, as well as technically.

Expatriate scientists/technologists can be assured that they are most welcome if their experience and know-how can be of national interest. Asking for highly paid jobs, putting too many preconditions—perhaps an option to go back—only shows that they are not confident of achieving success in an Indian environment. It is hoped that another white elephant is not created, further draining our national resources.

Raj Kumar Jain

Dr. Jain works at Bangalore

I WOULD like to draw the attention of the government that India is a country where majority of our people are illiterate, where science is not understood by masses and where theoretical education is imparted in our institutions. Under such conditions, creation of a Science City is a meaningless exercise.

Sudip Dutta

Mr. Dutta works with the State Bank of India, Dist. L. Subansin, Arunachal Pradesh

IT is unfortunate that the Indian scientific community should have responded in such a hostile manner to a project which plans to establish a high-tech cell in the country for which the expertise, resources as well as funds will be entirely provided for by Indian scientists resident abroad. The latter are discharging their obligations to their motherland since apart from a site to locate their venture they are not making any demands on this country. This sort of entrepreneurial endevour will bring in its wake a fillip to our industry as well as provide employment to a large number of resident Indians. Furthermore, as I understand, any resident Indian scientist who, like the promoters of the project contribute their own financial share would also be welcome to join in Since the produce of this venture would be export oriented it is expected to generate a good deal of scarce foreign exchange.

What perhaps has created the whole regrettable misunderstanding is the name accorded to the project—Science city—although it is needless to say any high-tech venture will have a sizeable R & D component. It is likely that the first few letters from emigre scientists appearing in *Nature* which cast aspersions on the ability of Indian scientists, ignited the flames of passion. These letters were uncalled for It is, therefore, clear that the Indian resident scientists have nothing to fear and should in fact welcome their brethren from abroad The project, however, should not be called Science City

A. Purushottam Reddy

Shri Reddy is an entrepreneur based in Bombay

I FEEL that the Science City, or for that matter any Science centre, should revolve around the needs and necessities of a common man, wherever possible. There is no reason to assume that local technology or traditional methods need to be replaced overnight But an appropriate import of technology to modify the existing method will certainly induce the essential involvement and rapport between a commoner and a scientist. Failing which, the Science City will become another Ivory Tower.

With this view, I have sketched a scenario entitled, "A Decade After" of a department of Science City.

M. S. Gore

THE Science City had at last arrived *a la* concrete structures. Christmas trees, wild bushes, etc. Wilfully or mistakenly the plentiful sunshine, so much adored since ancient times, was not allowed to have access to the vast rooms and corridors of the Science City. So in times of power failure or load shedding, which was frequent, the scientific community did grope in the darkness at noon.

Prof. Linga was meticulous about details. During one such darkness at noon, he mused pleasantly as to how he had ruled with an iron hand in the Final Civil Construction Committee Meeting in favour of commodes and running hot and cold water facility. As the flush could not be guaranteed to operate and tissue paper could be provided to those more equal than others, local scientists discovered that a plastic bottle was more reliable. Of course, there were locally suitable facilities, but they were too far and were frequented by malis, watchmen or other low paid workers.

Prof. Linga had arrived a decade earlier in the then proposed Science City. Whether he was invited or he had imposed himself is too confounded in the correspondence to discern. Nevertheless, he had landed in the Science City to investigate the usefulness of "mucon treatment" for Indian foods. The objective was essentially simple, but in the course of time he was totally convinced by the power he acquired unknowingly or by that which was granted to him that, the mucon treatment could solve many problems concerning Indian foods. While in the foreign land, he himself had worked on some applied aspects of mucon treatment and had a few papers to his credit.

There is no reason to belittle Prof. Linga. His true area of research was epithelial cells and he had made superlative contributions in the field. Very little is known about who and what tricked him to enter mucon treatment, that too in India. Nevertheless a large number of Indian scientists, mostly graduates,and a few foreign trained Indian scientists were engaged ostensibly for the work on mucon treatment of foods. Knowingly or unknowingly he had lorded himself over the others as an expert on the applied aspects of mucon treatment. This was not easy but he had managed it in a *democratic manner*. Practically, every paper emerging from the mucon treatment laboratory either

DEBATE CONTINUES

A decade after

showered profuse acknowledgements on him or had his name as the principal investigator.

Prof. Linga had developed a logical and unassailable technique towards this end. The mucon treatment laboratory was his brain-child: he had tirelessly supervised the installation of the machinery (that it was almost a discarded piece by the donor country, he was vaguely aware). So it followed automatically that any work on mucon treatment was possible only because of his outstanding contributions in importing it. This was a fact and could never be challenged and so every article carried his name. Some scientists, who did some original work, not necessarily concerning mucon treatment and did not put his name on the articles, discovered

that the approval time exceeded two years. Eventually it became a routine practice in the mucon treatment laboratory to add his name reflexively in any article. In a decade there were more than a hundred publications to his credit. These included articles on economics and engineering which by any stretch of imagination were not his fields of activity.

He was a vehement participant in symposia held abroad. The invitations for symposia or requests for sponsoring someone were always directed to him. He found it convenient to sponsor himself and invitations he would never refuse.

With his busy schedule he hardly had any time for discussions with his subordinates. He had not liked many of them because they spoke *Hinglish* with different provincial accents and at times they had the audacity to speak and seek approval for projects more in favour of time-honoured methods which included leaves, roots and *neem* oil. At times, he did remember that his own professor in a foreign land always encouraged discussions, arguments which he heard carefully. At times the stentorian voice of his professor boomed into his ears during the darkness at noon. It said, "My dear, you alone could be excellent upto a point. Beyond that your job is to locate excellence and promote it. Open discussions without prejudice is one way to locate it; there could be many other ways. But mind you, *power* is not one!" As the power returned illuminating his executive desk, the stentorian voice disintegrated into nothingness. Prof. Linga continued his drafting. "Effective treatment... social impact... malnourished masses... easy availability... low cost... lack of indigenous technology...

Eventually the local scientists had opted, perforce, to pursue their jobs merely as means of survival.

Prof. Linga was not a happy man nowadays. Housing was not a problem for him as he already had one. His sons had gone abroad and one had opted to settle over there. (Incidentally, some Science City graduates had shunned mucon work, gone abroad and settled there. He had called them traitors). The situation was truly disturbing. Many people had realised that mucon treatment was not as good. Some of the traitors had written to the local scientists that mucon treatment was too impractical and was in the process of being discarded. The international body was not as enthusiastic. The upstarts were asking for the output in relation to the vast sums spent. To this he would shrug his shoulders on the pretext that the research was ahead of its time and did involve vast sums of money. The rats, to whom he had fed mucon-treated diets had not died exactly as well. In fact this did not bother him. After all he had seen the locals sorting food from garbage and eating it too. And so, mucon-treated things would certainly pass off.

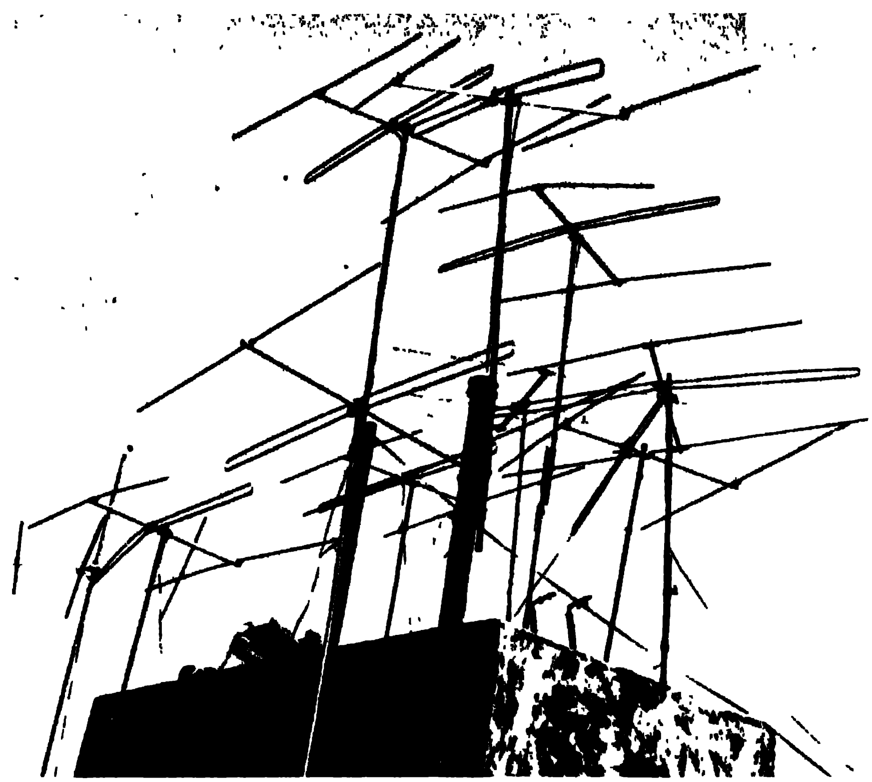
The threat was truly alarming and it hurt. The foreign land from where he had acquired the post in the Science City was abandoning the old and exploding new dimensions. The new vision now concerned mucon treatment (hereinafter referred to as wucon-c treatment) for sterilisation and disposal of city wastes. A foreign trained Indian scientist was landing in a month's time. A plot of a few acres in the expanded Science City was already allotted for constructing new laboratories, exclusively to assess the utility of wucon-c treatment in the sterilisation of disposal of city wastes.

For the first time Prof. Linga wondered as to who and what prompted him to discontinue his brilliant work on epithelial cells and tread into mucon work.

Just a kilometre away from the exclusive fast food joints of Science City, a half-clad *kala aadmi* was briskly selling a handful of salted groundnuts for the lowest denomination coin. Even without knowing the basics of proteins and fats or carbohydrates, the half-clad was at least providing some nutrition to all including those who sorted food from garbage. "A practising nutritionist" exclaimed Prof. Linga. He paid a coin and asked for the salted delicacy to the utter surprise of all those around there. He was not ashamed. He felt he could have followed George Washington Carver. His eyes were moistened but he knew what to work, for whom to work and where to work. The stentorian voice reassured him. "There could be many other ways to locate excellence. But mind you, *power* is not one".

M. S. Gore

Dr. Gore works in the Biochemistry and Food Technology Division, Bhabha Atomic Research Centre, Bombay.



WHO MINDS THE ANTENNA!

P. J. Joglekar

FIRST, the black and white sets, now the rush for colour TV. Television has come to stay as a means of entertainment, if not education, in the larger cities. And several TV antennas crowding close to each other on a small terrace is a common, though unaesthetic, sight in cities like Bombay.

Such overcrowding of antennas can cause mutual interactions and result in disturbances on the TV screen. Though the antenna accounts for less than 10 per cent of the total cost of a TV set, it decides in a big way the quality of the picture. A shaky or 'snowy' or unsteady picture and ghost signals or multiple images are the two types of common troubles in which the antenna figures prominently, if it is not properly chosen or fixed. Yet, the antenna is the most neglected part of the system — neglected by the manufacturer as well as the customer. While all the fuss is made in choosing a TV set, the crucial job of installing the antenna is left to the unskilled technician who is hardly competent to do the job.

Why is the antenna so important? The TV signals radiated by the TV transmitter reach our places through radio waves. It is the job of the antenna to pick up as much voltage as possible from these waves and deliver it to the TV set. If the signal pick-up is too weak, random voltages or 'noise' which get into the TV set can disturb the pictures, just as you get 'noise' on the radio when sound reproduction is disturbed. Noise also arises inherently within the TV set itself from resistors and transistors, or it may be caused by external sources like electrical appliances such as tube lamps, fans, and motors in the neighbourhood. Noise can create random white spots on the screen, like "snowing". When the noise is stronger, it interferes with the synchronisation of picture scanning.

The TV picture is transmitted and reproduced dot by dot by scanning from left to right and top to bottom. The scanning of the reproduced picture is held in synchronism with that of the transmitted picture by synchronising signals which are transmitted at the end of each horizontal line (horizontal synchronisation) and vertical field which is known as vertical synchronisation. When horizontal synchronisation is disturbed, slant black and white lines appear on the screen, particularly when a vehicle passes nearby. A still stronger noise affects vertical synchronisation—the picture starts slipping vertically. The relative strengths of the TV signal pick-up and noise or the signal-to-noise ratio is thus an important factor which determines the picture quality.

Since the external noise environment varies from place to place, the minimum signal strength to get a satisfactory picture also varies from place to place. It is more in the urban areas than in rural areas. In general, however, a millivolt signal at the TV set should give good pictures.

At any location, the strength of the TV signal depends on how far the place is from the transmitter and also on the presence of obstructions like hills or tall buildings on the path of the signal. If the signal is strong, for distances, say, up to a few km, one could use an indoor antenna; metallic objects near the antenna can, however, affect reception, so one would have to find a good location by trial and error.

As the signal strength decreases with distance, more elaborate systems are required at longer distances. Most popular are the three-element Yagi antennas used in the main area of coverage for their simplicity of construction and low wind resistance (called so after the Japanese engineer who first reported in English Prof. Uda's original Japanese work, more appropriately, it should be Yagi-Uda antenna).

These antennas have a stronger signal pick-up than that due to a dipole because they have directivity, that is, these antennas have more pick-up in some directions than in other. The antenna therefore has to be oriented such that the direction in which its

pick-up is maximum coincides with the direction in which the TV waves arrive. If the direction is not known, one rotates the antenna till one gets the best quality picture. The antenna then needs to be fixed such that it would not rotate because of winds, etc; if not, its pick-up would be low.

Obviously, the same antenna cannot be used for two stations in different directions with respect to the TV set. In western countries where transmissions are available on more than one channel in a place, the transmitting antennas of different stations are often mounted on the same tower to facilitate the orientation of the receiving antennas.

In remote areas, multi-element antennas can be used with advantage. However, the signal pick-up does not increase proportionately with the number of elements. For example, a three-element antenna will give a voltage pick-up about twice that of a single-element antenna, a six-element antenna about three times, and a 15-element antenna only four times that of a single-element one. And this extra pick-up is possible only when the antenna dimensions are properly chosen.

Three dimensions are associated with each element (or rod) of an antenna—its diameter, its length and its spacing from the driven element (to which the feeder wire is connected). Thus for a six-element antenna there are 18 dimensions to choose. A change in any one dimension can be compensated by a change in another. As there are too many parameters to be optimised and as no theoretical analysis is available, dimensions for multi-element antennas are chosen experimentally. If the dimensions are not proper, one cannot get the full benefit of the extra elements. It may so happen that a badly designed antenna with more elements may give less pick-up than a properly designed antenna with fewer elements.

Usually Yagi antennas work satisfactorily for a single channel only. Since TV coverage in India has been planned to provide only a single channel service, these antennas are adequate to

Common troubles associated with the antenna: snowing caused by weak signal (top), picture rolling up or down when there is no vertical synchronisation (above, left) and diagonal bars appearing when there is no horizontal synchronisation (above, right)

catch TV signals in whose primary service area the set is located. Though signals from distant stations are also received at times in many places, their channel allocation may not facilitate the use of one antenna to receive all the stations available at a particular place. Further, even if the channels happen to be conveniently allotted, the directions of different stations with respect to the location of the TV set would be different. This would therefore not permit the use of a single multi-channel antenna. Generally speaking, one would need a separate antenna for each station of interest. If the TV coverage in our country is augmented in future to provide a second channel then of course channel allocation would generally permit use of one multi-channel antenna to catch both the channels.

Another important factor is the weakening of the signal over the feeder wire, which connects the TV set with the antenna. A good quality feeder wire weakens the signal by about 10 per cent per about 30 metres length. Because of their poor quality, feeder wires commonly used in India cause much more weakening. In areas of weak signal, this may be a serious problem and can be compensated by using a booster amplifier at the antenna (see box).

Ghost signals

In many TV sets, ghost signals are seen, that is, same picture details reappear on the screen with some horizontal displacement. Mainly, there are three reasons for ghost signals: (i) reflections of TV signals from nearby buildings, hills, etc, (ii) mismatch between the antenna, the feeder and the TV set and (iii) effect of other antennas in the vicinity.

When ghost images appear due to reflections from buildings and hills the problem is rather complicated. In a few cases, one can find a good location on the terrace of the building and/or turn the antenna to keep the ghost images to the minimum. But there can be some really difficult situations where it may not be possible to get over the problem.

TV signals picked up by the antenna propagate over the feeder wire and reach the TV set. If these three are not matched with one another at the TV channel frequencies the waves travel back and forth between the antenna and the TV set and ghost signals are produced. This situation is similar to the multiple echoes which are heard when a source of sound is located between two walls. If the feeder length is small, the ghost signal is very close to the picture and may look like a shadow or reduce the sharpness of the picture. In the case of a long feeder wire, the ghost image is separated from the main picture sufficiently and can be seen distinctly. In the case of a severe mismatch, equally spaced multiple ghosts appear. The actual concept of matching is rather complicated and the job is made further difficult because there are no simple tests available to check the matching at the customer's place. It is therefore primarily the

Boosters

THE use of booster amplifiers in weak signal areas (so-called fringe areas) will help only if the booster produces less noise than the tuner of the TV set. Since the components used for the booster can also be used for the tuner, a booster cannot offer any special advantage over a TV set specially designed for fringe area reception. An exception to this will be in cases where the feeder loss is excessive (either due to the long length or the poor quality of the feeder). Therefore, for improving the reception in fringe areas, the use of a higher-gain antenna is always the first step. In situations where external noise (arising from electrical appliances in the vicinity) is the controlling factor, a booster will amplify the TV signal as much as the external noise and hence would serve no purpose. This situation usually prevails in urban areas. In high signal areas, amplification provided by the booster can be a disadvantage because it [illegible] fringe reception at some lower bands. The situation may be similar in our country also though detailed studies on this point are not available. It appears that our manufacturers have not paid sufficient attention to [illegible] and, therefore, it is possible that a good booster may significantly improve the picture quality in fringe areas.

Incidentally, the reception of TV signals beyond the line-of-sight range depends upon peculiar weather conditions and fairly satisfactory reception is possible for certain time. It is known that dusty, pre-monsoon and post-monsoon [illegible] line-of-sight propagation. Only under such conditions, weak to fairly strong signals are available at very long distances. Under normal conditions, signals get far too weak a little beyond the line-of-sight.

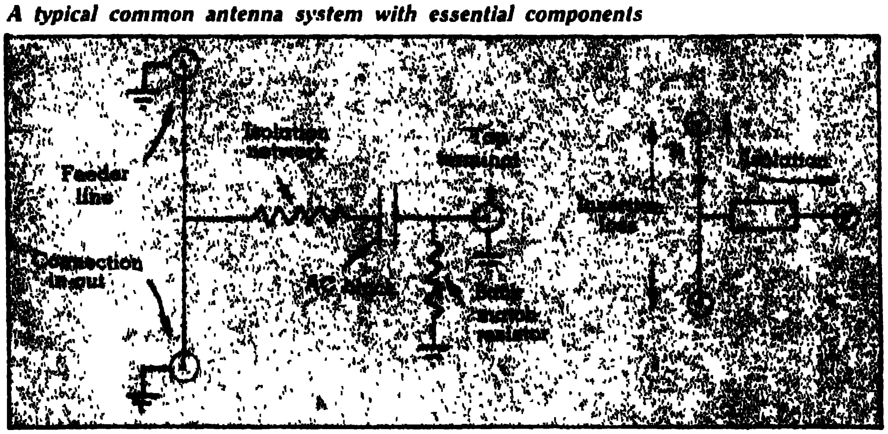
manufacturer's responsibility to check on this point. Even when the antenna is installed by the manufacturer's team, the job often remains quite unsatisfactory because the antenna technicians are usually unskilled workers who know nothing about matching. TV technicians who repair TV sets also have very scanty knowledge about antennas. The same can even be said about TV design engineers who know electronic circuits inside the TV set but do not necessarily know much about the antenna.

Other antennas in the vicinity can seriously affect the performance of a TV antenna. This is because one antenna induces currents in the other and an interaction takes place (due to electromagnetic coupling of antennas through TV waves). This develops a mismatch resulting in ghost signals. The interaction is maximum when the antennas are placed one behind the other in the direction of the propagation of TV waves. Experiments have shown that the minimum separation necessary in such cases is about 10 metres for three-element antennas for channel four (61-68 MHz). Multielement antennas need larger separation. In the sideways direction, a much smaller separation is sufficient.

Common antenna systems

While interaction between antennas can be minimised by carefully choosing their locations this becomes practically impossible when many antennas have to share the small space available on a terrace. The only solution in such cases is to use a common antenna for all the sets in the building or even for a group of buildings. While such systems are extensively used in other countries this idea has not at all been accepted by viewers in our country for various reasons, mainly misunderstandings in the minds of the laymen, some of which are deliberately spread by the manufacturers or dealers to boost the sale of their antennas. Some of them even contend that the performance of their TV set is guaranteed only if it is used with their antenna. When it is proposed that several flat owners in a building may share a common antenna the first they expect is a substantial reduction in the cost since only one antenna is going to be used by all the people. Unfortunately, this is not so because what is saved on the cost of the antennas has to be spent on the distribution system. When a prospective customer comes to know about this he backs out because he would rather prefer his own independent antenna in that case. He is not able to appreciate the benefit in terms of quality. Since the proof of the pudding is in the eating, a few well-designed common antennas need to come up in different parts of the city, particularly in problem areas for TV reception so that this idea can catch up.

A typical common antenna system with essential components



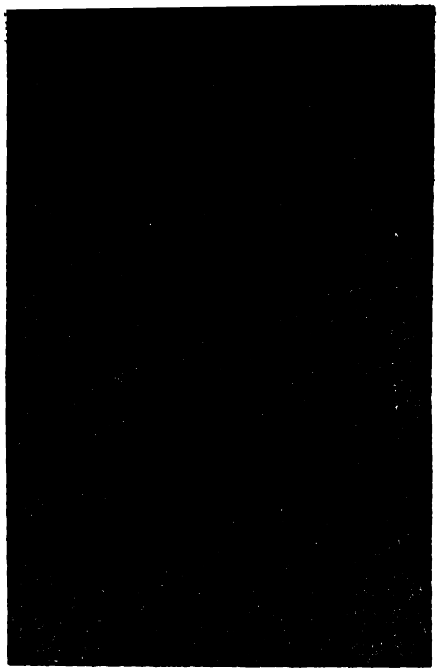
How does a common antenna work? A common antenna system as the name implies uses a common antenna to feed the TV signal to a number of TV sets. It uses a high-gain antenna which is specially designed for withstanding

rough weather conditions in an outdoor environment.

The signal picked up by the antenna is amplified by an amplifier and fed to different feeders through a splitter. The feeder wire runs from one floor to the other. At each floor, there is a tap point from where the feeder wire runs to the individual TV set. In order to avoid interaction between the TV sets, an isolation network is provided at every tap point. This isolation network weakens the TV signal reaching the set to 1/8th to 1/10th of its original value. The TV signal flowing further down the feeder line is also weakened by about 5 to 10 per cent. Thus every tap point introduces loss of TV signal. This has to be compensated by boosting the TV signal by an amplifier before connecting it to the feeder wire.

If there are more than one channel available at the place, usually a separate Yagi antenna is used for each channel. The signals picked up by these individual channel antennas are mixed in a mixer circuit and then fed to the master amplifier which can have a wide bandwidth to cater to all TV channels. Thus no separate amplifier is required to amplify each channel, provided the signal pick-up for each channel is about the same. If the signal picked up on one channel is too weak, it needs a separate pre-amplifier before connecting it to the master amplifier.

In some installations, it becomes necessary to run separate feeder wires to connect different portions of the building. For example, all flats on the east side may have one feeder wire, whereas all flats on the west side may have another feeder wire if there are separate staircases on the east and west sides. Therefore, the output of the master amplifer is split into two or four different outputs by splitters. These devices also introduce a loss in the through path and isolation between the two paths. The connecting devices such as mixers, splitters and taps introduce two types of losses—insertion loss and isolation loss. Insertion loss comes in the direct path whereas the isolation loss comes in the path of the interconnection. The signal reaching a TV set on the ground floor of a building will be subjected to insertion loss at all the floors above and isolation loss at the tap point on the ground floor. On the other hand, a set on the topmost floor will suffer only the isolation loss at the tap on the top floor. In order to give more or less uniform signals on all the floors the higher level floors use taps with less insertion loss and more isolation loss.



The common antenna distribution system for a 10-storey building

The choice of different units in the system is made by considering the layout of the installation and trying to provide satisfactory signal levels at all outlets and avoiding interaction between different outlets. The common antenna system is therefore a somewhat complex installation. It requires understanding of antennas, feeder wires and amplifiers. When the space on a terrace cannot permit individual antennas, a common antenna system is the only answer for getting ghost-free pictures.

The cost of a common antenna system depends upon the particular site. However, the cost per outlet is of the order of an individual antenna installation. Thus, a subscriber to a common antenna system bargains his independence for a better quality picture.

Antennas for colour reception

Are any special precautions needed for antennas for colour TV reception? Here again there are two problems, one is of weak signal and other is of ghost due to mismatch.

Colour TV transmits a colour subcarrier in the form of a colour burst (eight to 10 cycles of oscillations of colour subcarrier frequency) during each horizontal blanking interval. If the level of this burst is below a threshold, the TV set does not respond to the colour signal. Thus too weak a signal will fail to produce colour in the picture. Such a situation can also arise when the antenna does not have an adequate bandwidth. Thus the picture luminance signal is picked up well but the colour subcarrier which is higher than the picture carrier by 4.43 MHz is not picked up so well. In such a situation the picture will be produced only in black and white.

The use of a booster amplifier will be useful in weak signal areas to raise the level of the colour subcarrier above the threshold. Though the picture would be noisy it would have colour.

When there is a mismatch between the antenna and the feeder, the delayed signals produce ghost images. In black and white transmission these are grey and look like shadows. In colour TV, the time delay produces displaced image whose colour also changes with the delay time. This results in ghost images of various hues and can be very disturbing.

Thus proper antenna adjustments are more critical for colour reception than for black and white. A good antenna would give good reproduction for both black and white as well as colour. A bad antenna may give a tolerable picture on black and white but would not be acceptable for colour. If you are planning to buy a colour set, you may be able to use your existing antenna, if you are getting good quality picture on your black and white set. If the picture is too noisy or is giving ghosts, you may have to go in for a better antenna.

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Battle of the bulge

STRETCH your leg. tummy in, chin up turn around, bend back .. one, two .. ...the tape instructs and forty assorted women dutifully obey. Visions of slim, svelte, Fonda – like figures spur them on Outside, it is barely daybreak, but the streets are full of joggers

Magazines and tabloids carry prime space advertisements for health clubs and slimming clinics. For the urban Indian, fitness is becoming more than a fad, it is a cult Thin is beautiful and the battle against the bulge goes on.

Is there any substantial basis for this fear of fat? Why this obsession with obesity? To answer these questions, it is necessary to define obesity Obesity, fatness or excessive weight is defined as weight (in kilograms) divided by height squared (in metres). If the answer is greater than 27 5 (for a medium-build male) or 27 0 (for a medium-build female). the person is obese.

Obesity, though eventually leading to malfunctioning of different body organs, is hardly a disease in itself. An obese person is more susceptible to diabetes, heart disease, kidney trouble, osteoarthritis and post-operative complications Obesity can de tract considerably from the feeling of well being that characterises a healthy adult. Hence the fight against fat But what causes obesity?

In normal persons, there is a close coupling between the metabolic demands and caloric intake, so that weight remains relatively constant. If this balance is disturbed, obesity results. The reasons for this disturbance include damage to the hypothalamic satiety center, certain types of emotional disturbances, persistent high caloric intake or due to endocrine diseases, and last but not least, due to socially established patterns of eating. In most cases, obesity is a direct consequence of faulty eating habits.

Eating patterns are established early in life and are difficult to alter. Often, an obese child is an obese adult. Thus, when planning the diet of a family, it is necessary to have a clear idea of what constitutes sound eating habits. And to cultivate good eating habits, the role of food in body chemistry must be understood.

Food chemistry

The three, basic constituents of food—proteins, fats or lipids and carbohydrates, are oxidised in the body and the resulting chemical energy is made available for body functions But how much energy do we need every day? The values of the daily dietary allowance given by the Food and Agriculture Organisation (FAO) standards, for developing countries, is 3,200 kilocalories (70 kg body weight for men, in the 30-40 year age group) and 2,300 kilocalories (58 kg body weight for women, in the same age group). Nutrition research has provided us with the calorific values of different kinds of food. Since data is available for nearly all kinds of food, daily diets can be planned, based on these values.

Energy input and output

The energy made available to the body by the oxidation of food is used up in three ways: by basal metabolism, specific dynamic action and by physical activity. The break-up of energy used for these three processes is 60 per cent, 10 per cent and 30 per cent respectively. The basal metabolic rate (BMR) represents the energy expended daily for vital life activities. It is the body's housekeeping energy and generally, more than half the total energy intake is utilised for basal metabolism. The specific dynamic effect represents the energy utilised by the body for digesting and metabolising the food and finally disposing of the end products.

Recently, there have been reports on the so-called "negative calorie foods". The energy needed to digest these foods is higher than the energy that their oxidation supplies to the body. They, therefore, lead to a reduction in body-weight. However, it must

Energy involved in various activities

Activity	Examples	Estimated Kcals/hour
Sedentary	Sitting with little or no body movement, reading, writing, eating.	80–100
Light	Cooking, dusting, walking slowly, office work, ordinary laboratory work.	100–160
Moderate	Sitting with vigorous arm movements or standing with considerable arm or body movements, walking at average speed, vigorous laboratory work.	160–250
Vigorous	Moving the body rapidly, heavy housework, rapid walking, heavy gardening.	250–350
Heavy	Moving body at near maximum capacity, rapid swimming, tennis, running, etc.	350 and upwards

be remembered that such hard-to-digest foods are likely to damage the digestive system. Also, the contribution of the specific dynamic effect of food is only ten per cent of the total energy expenditure, and hence an increase of this factor is not likely to lead to a substantial reduction in body-weight.

Physical activity is responsible for the expenditure of about 30 per cent of the total energy-intake. The energy involved in the performance of common physical activities varies from an estimated 80 to 100 Kcals/hour on the lower side for sedentary activities to 250 to 350 Kcals/hour for vigorous exercises.

Obesity—fact and fiction

There are many misconceptions about gain and loss of weight. One such myth is that body weight increases with increasing age. What actually happens is that aging causes a decrease in the basal metabolic rate (BMR) There must be a corresponding decrease in food-intake, if body weight is to be maintained at the same level. Another popular misconception is that, hormones play a part in weight-gain. This is true only in cases of undersecretion of a thyroid hormone which causes a decrease in BMR This condition, also requires a reduction in food intake. Another erroneous belief is that mental activity consumes a lot of body-energy. Actually, the nervous system is continuously active and the energy requirements are the same for sleeping, worrying, day-dreaming or furious studying. Muscle tension during mental work causes a small but still insignificant expenditure of energy.

Another myth propagated by some weight reduction enthusiasts is that a single, violent burst of exercise can cause the dramatic disappearance of large amounts of body fat. Actually, weight loss after exercising is due to the loss of body fluids through perspiration. The "lost weight" is regained as soon as the body fluids are replaced

It is a popular belief that in many cases of obesity, sugar is the villain of the piece. This reasoning is not based on facts. One tablespoon of sugar (about 12 gms) on oxidation gives about 48 kilocalories of energy. This figure is small compared to the average daily requirement of about 2,700 kilocalories. What actually happens is that a large amount of sugar is consumed because it is present in a wide variety of foods. At the same time, the nutritive value of sugar is very low The carbohydrate requirement of the body can be easily met by other food items and the body can well do with much less sugar and sweets than we generally consume.

Low calorie sweeteners like saccharin and sodium cyclamate have long been in use. They indulge the sweet tooth and have only a small percentage of the calories that are supplied by sugar. Certain dipeptides like L-aspartyl-L-phenylalanine methyl ester and related compounds are nearly 200 times sweeter than sugar and are low in calories. However, they have not become popular because of undesirable side-effects. The search for low-calorie sweeteners continues to form an important area in nutrition research.

We now turn our attention to how each of the three basic nutrients is processed in the body and how the excess is stored. The carbohydrate content of food eventually reaches the intestine as mono and disaccharides which are finally converted to glucose. Glucose is oxidised for the body's energy needs and the excess glucose is reversibly converted into insoluble glycogen and stored in this form. The normal blood sugar (glucose) level is about 80 to 100 mg/ml.

Ingested fats are hydrolysed into glycerol and fatty acids. Glycerol is converted to glucose which joins the carbohydrate metabolic cycle. Some fatty acids combine with glycerol and choline to give phospholipids, which play an important role in the body. Other fatty acids are oxidised in the liver and muscles to release energy. Excess fats are stored in a special tissue called adipose tissue.

Proteins, the basic building blocks of the body, are broken down into amino acids during digestion. Some amino acids are retained by the liver while the rest enter the blood stream and are rapidly used up by various tissues. Excess amino acids are either processed for energy and heat or converted into carbohydrates and fats. Only about 58 per cent of the dietary proteins are metabolised into carbohydrates.

The long and short of being fat

It is obvious that the metabolic pathways of carbohydrates, proteins and fats are interlinked at several points. This permits a flexibility in the supply of nutrients and mutual substitution within fairly wide limits without causing serious injury to body tissues. The importance of carbohydrates and fats in the diet is that they exert a protein sparing effect, permitting proteins to be used for vital structural processes in the body. Generally, it is the excess fats and carbohydrates in the diet that lead to obesity.

The maximum capacity for the storage of excess carbohydrates is, on an average, about half a kilogram. Carbohydrates, in excess of this amount, can be converted into fat and stored in the adipose tissue. The body capacity for fat storage is much higher and the specialised adipose tissue is provided for this purpose The fat depots of the body are found under the skin, in the peritoneal cavity and interspersed with muscles. The fat under the skin responds first to dietary deprivation. It follows, therefore, that excess weight is mostly in the form of stored fat.

Revathi Narayanan

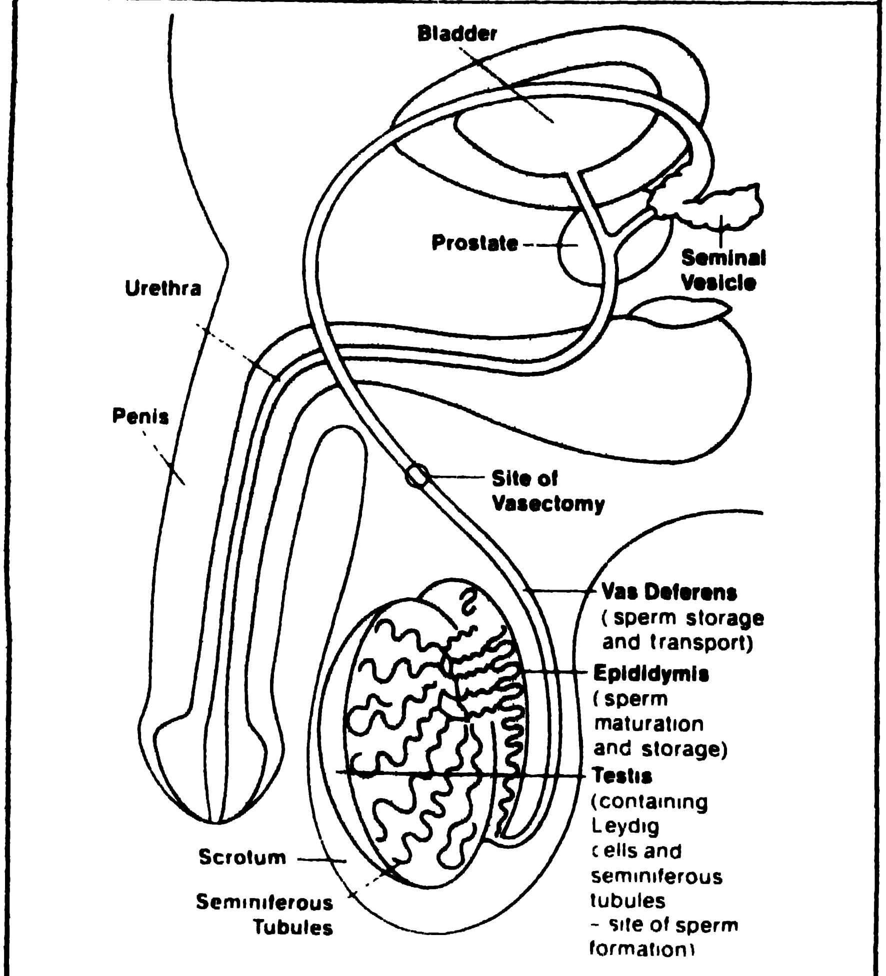
Dr. (Mrs.) Narayanan, a biophysicist, is a free-lancer from Bangalore

Measure for measure

The unit of heat or energy measurement in the human body, is the same unit that is used to express the energy value of food. It is known as the kilogram calorie (Kcal) or Calorie (with capital C) and is defined as the quantity of heat required to raise the temperature of one kilogram of water from 15°C to 16°C. The Kcal or Calorie is different from 'calorie', which is an energy unit of much smaller magnitude.

Very often the distinction between the Calorie and the calorie is overlooked, giving absurd results. Further, the calorie defined in terms of heat, gives the erroneous impression that heat is the form of energy used by the cells in the body. Actually the body uses chemical energy trapped in high energy molecules like adenosine triphosphate (ATP) A newer and more appropriate unit in nutrition science, is the kilojoule (the amount of work that can be accomplished by a given amount of energy).

Male Reproductive Organs



TOWARDS A MALE PILL

A. R. Sheth

S. B. Moodbidri

THE practice of contraception cannot be the sole responsibility of the female. Indeed, an equal onus also devolves on the male. And hence, an ideal birth control practice would be where a man and a woman share the contraceptive burden, alternating periodically in the use of their respective contraceptive. This in turn eliminates the hazard of continued exposure of one person to the contraceptive for long periods of time.

Why is then the woman the primary target of most contraceptive products? Why has there been no development of a male pill? This can partly be attributed to the complexity of the male reproductive processes and our basic understanding of the different processes has lagged at least fifteen years behind that of the female. Besides, it seems much easier to interfere with the release of a single egg once a month than to stop the development of millions of sperms in a day.

In order to understand the vulnerable links in the male reproductive process that might offer approaches to male birth control, we need to have at least a simplified view of the complex sequence of events that govern the production of sperms in the testes and their subsequent storage and transportation.

The testes are two ovoid bodies, about 40 millimetres (mm) long, located externally on the body in a sac called the scrotum. Internally each testis is partitioned into several compartments. The major components of the testes are the seminiferous tubules, where sperm formation occurs. These tubules are over 200 metres long, about 1 mm in diameter and are tightly coiled within the testicular compartments. All of them terminate in a small region containing a network of passages, the rete testis. Once formed, the sperms are deposited in the rete by the tubules and from there they move into the next portion of the male reproductive tract, the epididymis. The epididymis is a six metres long duct, where the sperms mature and are stored. During this maturation process, the sperm acquires its fertilising capacity and independent movement. Subsequent, sperms are stored and transported in the vas deferens, a duct nearly 30 centimetres long where they are suspended in the secretions from the seminal vesicles and the prostate gland to comprise the seminal fluid that is eventually ejaculated through the urethra into the penis.

Another important constituent of the testes are the Leydig cells, which produce the male sex hormone—testosterone—responsible for the male secondary sexual characteristics and libido.

The production of the sex hormone and sperms by the testes is maintained and regulated by the actions of the anterior pituitary hormones, gonadotropins, comprising the luteinising hormone (LH) and follicle stimulating hormone (FSH). The LH stimulates the Leydig cells in the testes to produce testosterone which maintains the male secondary sex characters; the FSH exerts its effect upon the seminiferous tubules to begin the process of sperm production and the secretion of a putative hormone called inhibin.

A complex negative feedback mechanism governs the concentrations of these hormones in the blood circulation—if too much testosterone is produced, the concentration of LH drops; conversely, if the concentration of testosterone falls below a certain level, then the LH concentration rises. The

Vasectomy does not affect male hormone balance, libido, erectile capacity or ejaculation

levels of FSH and inhibin are controlled by a similar negative feedback mechanism.

The secretion of pituitary gonadotropins is not only controlled by the testes which they stimulate through the feedback effects of testosterone and inhibin, but also by a part of the brain, the hypothalamus. The hypothalamus secretes hormones called "releasing hormones", one each for the pituitary hormone, controlled by it. However, a single releasing hormone, the luteinising hormone-releasing hormone (LHRH) is responsible for regulating the secretion of both LH and FSH by the pituitary.

Having understood the male reproductive process, the most obvious male contraceptive strategies then would be:

1. Interference with the transport of the sperm so that ejaculated semen does not contain sperm.
2. Interference with the maturation and storage of the sperm in the epididymis.
3. Interference with sperm production in the testes.
4. Interference with the hormonal mechanisms at the pituitary or the hypothalamic level which would disturb testosterone production and consequently the production of sperm.

Interference with sperm transport

The simplest way of interfering with the transport of mature sperm prior to ejaculation is to rupture or block the vas deferens. This is accomplished by vasectomy. Vasectomy is performed through a small incision on the scrotum, just above the testes. The vas deferens on each side is located and separated from arteries, veins and nerves. The vasa are then cut and tied, after which the scrotal incision is closed with a few stitches. The procedure is performed under local anaesthesia and can be completed in less than 30 minutes in a clinic or even a mobile unit. The patient can leave after a short rest and is usually able to resume normal activity the next day.

In physically and emotionally healthy men, vasectomy does not affect male hormone balance, libido, erectile capacity or ejaculation. However the fear of loss of potency rather than the apprehension about the simple operation itself has prevented many men from undergoing vasectomy. The other problem is that the probability of successful reversal of the method is limited. Restorative surgery consists of suturing the cut ends together. Functional success in terms of subsequent pregnancies occurs in 18 to 60 per cent of the cases.

Currently, vasectomy is irreversible, and the collection of an adequate amount of semen prior to vasectomy, and its preservation for eventual use in artificial insemination, is frequently mentioned as an alternative. Although, this method is still being perfected, a commercial sperm bank has been operating in the USA since 1972 which charges about 100 dollars for initial processing and another 25 dollars per year, for maintenance.

Interference with sperm maturation

Sperms that leave the testes through the rete testis and efferent ductulli are not capable of fertilising an ovum until they have matured as they pass through the first part of the epididymal duct. The chemical mediators of this maturation of sperm are still largely unknown. If the details of sperm maturation in the epididymis were known, this would perhaps be the most preferred site for pharmacological control of male fertility as there would be less risk of introducing genetic alterations at this stage than by interfering with the process of sperm production.

The contraceptive effect of a few organic compounds like alpha-chlorohydrin and 1, 2, dibromo-3-chloropropane has been studied in laboratory animals. Though, we have leads in the laboratory about how to interfere with sperm maturation, it will at least be 15 to 20 years, before a contraceptive of this type reaches the consumer.

Interference with sperm production

Interference with the early stages of sperm production is risky because of the increased likelihood of genetic mutations. A large amount of work has been done in this area, primarily using hormonal methods. In addition, direct pharmacological interference with sperm production in the testes has been observed using several types of synthetic organic compounds such as the dinitropyrroles and nitrofurans. These compounds have been studied in animals, and some even in humans but a variety of toxic effects were observed during the early stages of testing.

The most promising research effort involves testing of gossypol, a component of cotton-seed oil, that is apparently highly effective in stopping sperm production. Gossypol, a polyphenolic compound, present in the seed of the cotton plant (Sp: *Gossypium*, Family: *Malvaceae*), was discovered accidentally by Chinese medical scientists to have contraceptive properties.

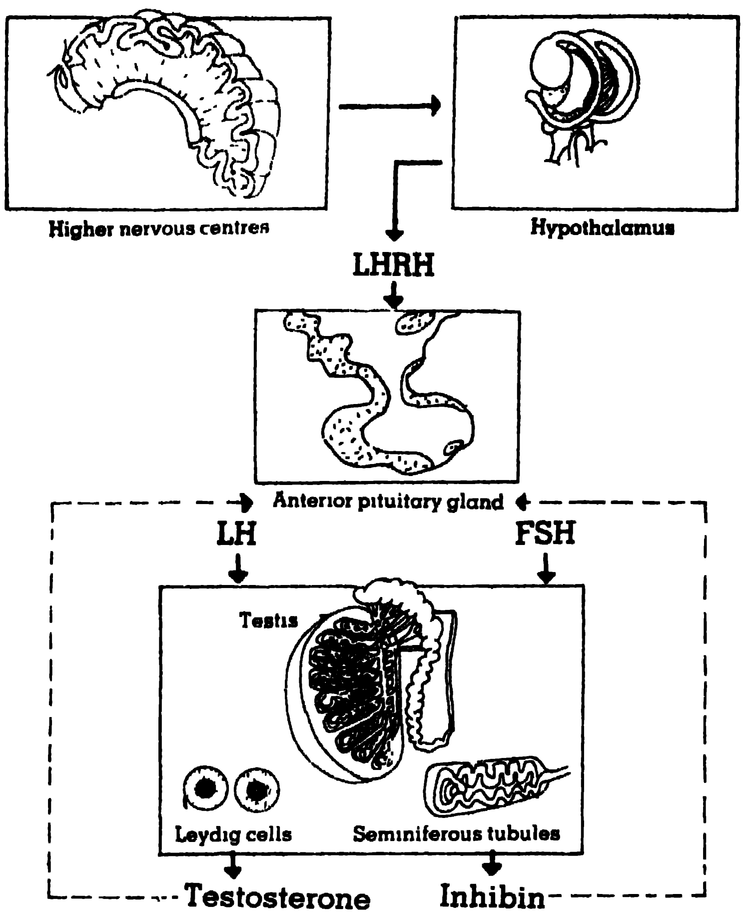
Since the initiation of the first trials in 1972, more than 8,000 men in 14 provinces of China have been treated with gossypol. It is taken daily for about two months until sperms are no longer observed in semen and then weekly to maintain infertility. The drug suppresses sperm production and also affects the structure and motility of sperm in the epididymis.

From the preliminary data available on the follow-up of recovery of sperm counts in men treated with gossypol, it appears that the chances of recovering spermatogenesis and a normal sperm count are greatly reduced with a longer duration of treatment. Side effects have included weakness, gastric discomfort, nausea, reduced appetite, decreased libido, disturbed potassium, metabolism which affects the heart. These problems of safety and reversibility of the antifertility action of gossypol have for the time being precluded its general use for fertility regulation in family planning programmes

Interference with hormonal balance

More work has been done on interference with the hormonal balance at the pituitary and testicular levels than on any other potential approach to male contraception. Unfortunately, hormonal interference tampers with a very complex interplay of various hormones and thus is likely to lead to a variety of actual or potential side effects.

Hormones involved in male reproduction



What the reproductive biologists have attempted is to inhibit the secretion of gonadotropic hormones, LH and FSH, by administration of excess testosterone or one of its long acting esters. Because of the negative feedback control mechanism between testosterone and gonadotropins, excess testosterone in circulation inhibits LH production, which in turn prevents endogenous production of testosterone within the testes, needed for sperm production. Thus ironically, the administration of high doses of testosterone actually inhibits sperm production, while maintaining libido and other secondary sex characters.

The inhibitory effect on spermatogenesis is completely reversible, the average time interval between the recovery of spermatogenesis and cessation of treatment being 18 to 34 weeks. However, this approach faces complications in the route of administration and possible side-effects. Studies undertaken over the past ten years using several regimens have shown that exceedingly large steroid doses are required and the method is of unreliable effectiveness. All the studies conducted so far indicate that only about one half of the treated male subjects develop azoospermia or the absence of sperm in semen. The most common side-effects of prolonged administration of testosterone, include weight gain, aggravation or reappearance of acne and reduction in testicular size. Further, though the clinical and experimental evidence is at best preliminary, it also suggests the possibility of increased susceptibility to atherosclerotic heart disease, on prolonged administration to normal males.

Estrogens and progestogens or the female sex hormones are also highly effective inhibitors of gonadotropin-release. Large doses can exert direct effect on the male reproductive organs leading to azoospermia. Again, the major problem is the production of undesirable side-effects, including decreased libido, impotence, breast growth and nipple pain. To overcome these adverse effects which follow long term use of estrogens or progestogens, the simultaneous administration of androgens or male sex hormones has been tried. When these compounds are used in combination for achieving male infertility, the dose of both androgen and estrogen or progestogen is less than if either of these compounds is used alone.

Of the various combinations tested so far in multicentric trials, depot-medroxyprogesterone acetate plus testosterone enanthate is the most promising combination. However, in these trials, azoospermia was achieved, in only 50 to 60 per cent of the treated subjects. Furthermore, azoospermia was not persistently maintained even while the treatment was continued over an additional period of time. In view of these considerations, it is clear that irrespective of the drug combination or the dosage used, it has not yet been possible to produce persistent and sustained azoospermia, which is an essential requirement for the development of a method of male fertility regulation based on suppression of sperm production.

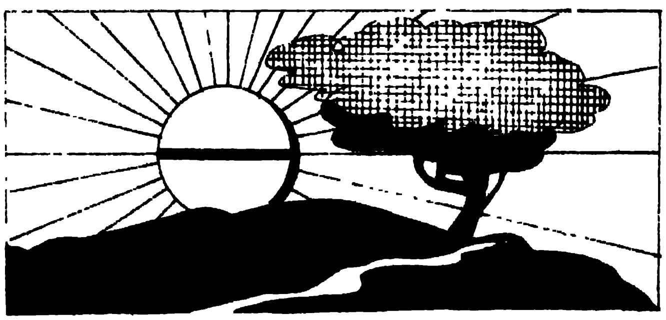
Work has also been carried out with synthetic hormones, "anti-androgens", which inhibit the biological functions of the male sex hormones. Cyproterone acetate is one such hormone with additional progestational activity that has been studied clinically for male fertility regulation.

Another potential area of investigation is the possible role of inhibin, a protein that is apparently produced by the seminiferous tubules in the testes, and exerting a negative feedback upon FSH. The logic of the argument which involved inhibin in the search for a male contraceptive was that if FSH is essential for the maintenance of hormonal sperm production, then selective suppression of FSH secretion by inhibin should render a man infertile without affecting libido since LH and testosterone secretion would not be altered. Although an attractive proposition, serious reservations are expressed regarding the development of this

approach into a practical method. First, there is no clear evidence that spermatogenesis in adult human males is solely, or even mainly, dependent on FSH Second, there is no inhibin preparation available today which is known to reduce the level of circulating FSH to zero. Third, inhibin being a protein, problems regarding the development of an appropriate delivery system so as to make the route of administration as well as the dosage regimens acceptable for long-term use, may be of considerable magnitude.

Yet another approach for specific FSH inhibition, is the specific neutralisation of FSH using active immunisation, which provides a promising immunological method for male fertility control. However, several aspects must be clarified before the immunological neutralisation of FSH can be considered a feasible and acceptable method.

Another research effort involves, testing man-made analogues of luteinising hormone releasing hormone (LHRH). LHRH is a brain hormone which serves to trigger the release of LH and FSH by the pituitary. LHRH, a small peptide consisting of a chain of ten amino acids, in its natural state is too weak to be used as a contraceptive. In addition, it tends to be inactive when taken orally.



FRANCIS H D'SA

These obstacles could be overcome by synthesising analogues which are more potent than the natural molecule and retain their effects when taken orally. Repeated administration of the superactive analogues produce a sharp rise in LH, FSH and sex steroids levels, followed closely by a decrease far below normal. In a manner not yet understood, the super-active analogues overstimulate the pituitary gland and exhaust its ability to respond further to the analogue. It is this paradoxical response which provides the basis for using these super-active analogues as contraceptives However, suppression of spermatogenesis by this route is again likely to be associated with negative side-effects.

Clearly the course of male fertility control for the balance of this century has virtually been determined. We cannot conceive of a single new non-surgical contraceptive procedure—chemical or non-chemical—that could be brought to the public because of the exceptionally long time involved in developing new contraceptive measures. □

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'SHIFT' IN THE BIOLOGICAL CLOCK

Nearly one hundred body functions in human beings vary periodically in a clock like manner Body temperature is one such function The body temperature rhythm in humans was the subject discussed in a paper that Davy presented in 1845 to the Royal Society Temperature of the body is easily measured either in the oral cavity or in the rectum High temperatures are recorded at around 3 p m whereas the lowest temperatures occurred around 3 a.m coinciding with deep sleep These rhythms are found to *persist* in people maintained in isolation bunkers' in the absence of time cues They then become circadian and the period (measured from peak to peak or trough to trough) freeruns and goes beyond 24 hours about roughly an hour Under such conditions of freerun the circadian rhythm in sleep-wakefulness and the circadian temperature rhythm often 'dissociate and show markedly different periods.

The temperature rhythm is a conveniently recorded indicator serving much like the 'hands of the circadian clock Reinberg et al., have recently reported (*Nature*, **308**, **272**) on the oral temperature profiles of human subjects in the context of their showing good tolerance or intolerance to shift work. A large number of such workers report problems of insomnia, fatigue and uneasiness Dr A Reinberg is a leading French Chronobiologist specialising on human circadian rhythms The main conclusions of the paper by Reinberg et al, may be summarised as follows

□ Human males showing *good tolerance* to shift work had a stable circadian period close to 24 hours

□ Human males showing one or many clinical signs of shift work *intolerance* had an unstable and variable circadian period

□ When the experiments were conducted on the same subjects their *good tolerance* to shift work was expressed when the period of their circadian temperature rhythm was close to 24 hours and *poor tolerance* was expressed when the period drifted and became less or more than 24 hours

□ The activity rest rhythm maintained its exact 24 hour periodicity in spite of the shift in work schedule In other words the activity-rest rhythm and the temperature rhythm dissociated in *all* subjects The dissociation was greater in poor tolerators

The studies employed 83 subjects volunteers, all males The subjects had monitored their own oral temperature every 4 hours (5 to 8 times a day but *not* during sleep) over 16 to 30 days

The type of dissociation reported by these authors are similar to those reported in the freerunning rhythm experiments on isolated human subjects The jet lag and the fatigue accompanying transcontinental travellers are also attributed to internal desynchronisation/dissociation of the several body rhythms The paper under discussion is an interesting and important contribution in understanding chronobiological implications of human activity A drawback in methodology (to which the authors themselves refer) is the fact that measurements were made at unequal times and not at all during sleep

The periodicity of human circadian rhythms has been implicated often in medical literature and psychiatry One theory has it that even endogenous depression in humans may be traced to the circadian rhythm being out of tune with the societal day (which is always the geophysical 24 hours). The medication administered in such cases such as lithium salts, is supposed to appropriately lengthen or shorten the subjects period and help them to entrain to the 24 hours societal day

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Cryo-electron microscopy of viruses

In an electron microscope a beam of electron is used for illuminating the object as against visible light in optical microscopy The electron microscopic studies of biological specimens are limited to nonliving cells, preserved close to the living state, since during sample preparation a viable state of the specimen cannot be maintained However, due to the much higher resolving power of the electron microscope a superior definition of the cellular ultrastructure as compared to that of an optical microscope can be obtained

Preparatory procedures for routine observations of biological specimens by electron microscopy include chemical fixation dehydration, embedding and staining procedures which produce remarkable electron micrographs However, these treatments destroy biological activity extract most soluble components, including numerous macromolecules and limit to a great extent the cytochemical and immunological reactions In order to reduce fixation artefacts, tissues are infiltrated with cryoprotective agents such as glycerine to prevent ice crystal formation cooled in liquid nitrogen, and sectioned by cryo-ultramicrotome in which the specimen and the knife are maintained at very low temperatures These sections are stained positively by uranyl lead salts on negatively using potassium phosphotungstate (KPT) to obtain excellent preservation of fine structure of cells

In the early days of electron microscopy, small biological structures such as viruses or bacteria were often studied as a whole by negative staining In this technique a small droplet of suspended particles is mixed with a heavy metal salt such as KPT and placed on a formvar coated grid Excess suspension is removed by touching lightly with a filter paper, leaving behind a thin film of solution During evaporation at room temperature KPT surrounds particles on the support film as a result of surface tension interactions and penetrates into the open irregularities at the cell surface In the electron microscope, the negatively stained particles appear as light areas because of the low scattering power of the particles compared to the dense surrounding stain It was soon realised that negative staining modifies biological structures Air drying of negatively stained virus particles was found to cause reorientation because of liquid flow, and disruption by surface tension forces In order to eliminate artefacts introduced by air drying, freeze drying procedures were introduced by Wyckoff in 1946 The term freezing usually implies the process in which liquid water gets converted to ice However, biological systems are complex and contain a mixture of aqueous salt solutions and colloids which separate into pure ice crystals within a liquid-salt water phase when the temperature is lowered Since slow freezing aggravates structural alterations due to phase separation, denaturation and osmotic effects, fast freezing of the specimen is commonly employed

Virus particles are absorbed on to the specimen grid and the sample is frozen by immersing it in liquid nitrogen. Drying is carried out in specially designed freeze-drying units by increasing the temperature of the specimen from −180°C to −80°C.

Electron micrograph (× 42,000) of the T4 bacteriophage brings out its head and tail structure clearly

Water molecules are allowed to sublime by introducing a cool trap in the vacuum chamber so that the movement of water molecules is directed from the specimen at −80°C to a cool trap at −150°C. Three steps are involved in freeze-drying (1) rapid freezing (2) sublimation of ice and (3) visualisation of structure by electron-microscopy which may involve shadowing, replication, positive or negative staining

Improvement in preservation of viral structure became evident when influenza virus particles which appeared pleomorphic by negative staining showed uniformly regular structure on freeze drying. Another typical example of air drying artefacts is provided by oncogenic RNA viruses such as murine leukemia virus and mammary tumour virus which display long protrusions called tails or other pleomorphic appearances when prepared by negative staining technique using KPT or ammonium molybdate. However, freeze dried viruses did not show any evidence of tail.

With improved freezing methods, it is now possible to rapidly cool pure water or aqueous solution into vitreous or amorphous solid water without the formation of ice crystals. In the article "Cryo-electron microscopy of viruses", (*Nature* **308**, 32) Adrian et al have used this method for finding the structural details of viruses unaltered by chemical fixation or physical damage introduced normally in the freeze drying technique

A small drop of viral suspension (5 μl) is applied to an uncoated copper grid or the specimen is mounted across the holes of a hydrophilic carbon film on a copper grid. Most of the liquid is removed with a blotting paper and the grid is immersed in liquid nitrogen. This transforms the thin film of liquid water containing the specimen stretched over the grid holes into a vitreous state. The grid is then quickly transferred into the cold stage of the electron microscope to maintain the specimen in its vitreous state, this also reduces the specimen damage caused by the electron beam during observation

The technique prevents preferential orientation of virus particles due to surface tension forces. Electron microscopic observations carried out at low temperatures, (110 K) help to maintain the original distribution of the virus particles when the unsupported vitrified layer of suspension is much thicker than the particles. The authors report excellent preservation of adenovirus, Selmiki Forest virus and demonstrate revealing structural details of the tail and particularly arrangement of DNA in the head region of the T4 bacteriophage (see Fig.) The finding that the dimensions of the frozen hydrated particles are close to their dimensions in liquid solution demonstrate that the technique introduces minimal artefacts and produces images of good contrast. Cryo-electron microscopy of vitrified viral preparations appears to be an important step in the electron microscopists' quest to attain the ideal of observing living cells in natural hydrated conditions

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Drinking to one's health?

CIVILISATIONS have fallen and wars won and lost, policies formulated all for alcohol. Alcohol, in one form or the other, has always been used by man for its pleasant taste and alleviatory properties. And often it has been abused, with serious health consequences, cirrhosis of the liver (fatty liver) and cardiovascular diseases, being the common ailments affecting alcoholics.

Between the regular bingers and teetotallers, a large majority consume alcohol moderately. This group has come under increased scientific scrutiny in recent years.

Previous studies had hinted of a possible association between moderate alcohol intake and decreased incidence of coronary heart diseases, implying that it might even be beneficial. In other words, alcohol was advocated to protect oneself from heart diseases. But today this protective role is again under review. These studies are based largely on observations of levels of certain components of circulating lipoproteins, cholesterol carriers in the blood. Cholesterol deposition in the blood vessels is known to cause atherosclerosis or the hardening of blood vessels, eventually leading to heart diseases

In normal human beings, plasma lipoproteins are divided into three broad classes based on the content of apoprotein B, the major structural protein of plasma lipoprotein—chylomicrons, liver-derived lipoproteins (VLDL or very light density lipoprotein, IDL or intermediate lipoprotein and LDL or light lipoproteins), and the HDLs, or (high density lipoproteins). Several studies have revealed that serum lipoprotein concentrations are strongly predictive of the risk of coronary diseases. The incidence of coronary diseases has a positive association with LDL cholesterol levels. However, the relationship between the HDL cholesterol levels and coronary mortality is more complex. High HDL cholesterol levels are associated with low coronary mortality. And elevated levels of circulating HDL observed after drinking alcohol were said to confer protective action.

However, HDL is a complex lipoprotein with two major subclasses: the less dense HDL_2 and the more dense HDL_3. The former has been associated with a reduction in coronary disease while the role of the latter is not yet clearly understood. Even factors like exercise and female sex hormones, known to reduce the susceptibility to heart diseases, have an elevating influence on HDL_2. But all these observations were made in subjects who drank heavily.

A study conducted at Stanford University on subjects who consumed moderate levels of alcohol revealed interesting results (*The New England Journal of Medicine* **310** 80). 24 clinically healthy men, who did not smoke but who had an average of at least one drink a day, were randomly divided into two groups of 12 each. One group continued with its normal drinking while the other was told to abstain for the first six weeks of the trial and then to continue with its usual drinking for the next five weeks. Laboratory and other measurements were made in all subjects at the end of each period. It was found that those who drank moderately (about 12 to 15 gm of absolute alcohol per day) increased their levels of HDL_3 and not HDL_2. Abstinence also reduced the HDL_3 level but had no effect on HDL_2.

This study clearly questions the validity of the earlier reports and the derived implications like "nonexercisers can maintain the levels of HDL similar to those of individuals who jog regularly by ingesting three beers a day".

Moderate drinkers may still be left with the question. To drink or not to drink? Well under situations which demand sound judgements, quick response, etc. abstinence is advocated. Otherwise, go ahead and cheers till a new alarm begins to sound.

B.S. Mahajan

CONVERSING WITH COMPUTERS

S. Arun-Kumar R. Chandrasekar
Kamal Lodaya Paritosh Pandya
R. Ramanujam

LAST month we defined a language for developing algorithms starting from their specifications. We shall call this language Quintessential Programming Language (QPL) QPL is not just a notation for expressing algorithms. The programs written in this language can also be executed provided they involve only numbers, letters and certain other special characters. Though pulao cannot be made on a computer, QPL is a convenient language to express its algorithm. It is in this sense that mere algorithms should be distinguished from programs.

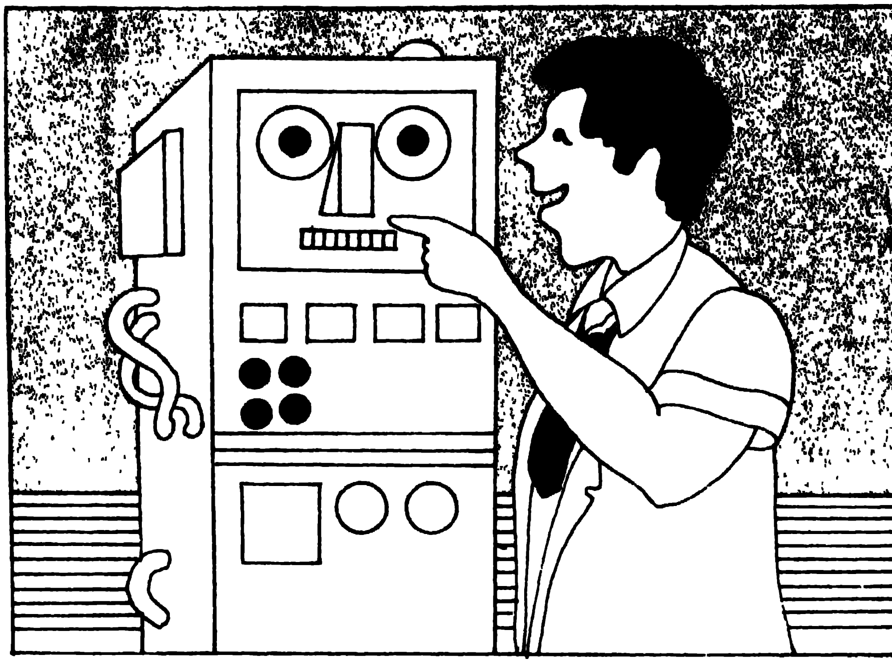
Let us try to understand, broadly speaking, what we mean by a program.

We are all quite familiar with the word *state*. Mothers are always complaining about the state of their children's rooms; people talk constantly about something being in a "sorry state of affairs", and so on.

Let us now try to make its meaning more precise. Take a light switch It can either be ON or OFF So we can say that a switch has two possible states—ON and OFF We may also say that the state of a home library at any instant is the set of books that are on its shelves. In a large library, the position of each book matters too. In this case its state is specified by the set of books and the rack on which they are stacked

Similarly, we may say that the state of the computer is the set of values that are stored in its memory. The *state* of a program is given by the values of the variables in the program When a program is being executed its state changes from a given *initial state* through several *intermediate states*, to the desired *final state* In the case of *interactive programs* (where the user usually sits at a terminal and executes the program), the state may also be changed by the user. These programs usually wait at certain points during their execution for the programmer to supply data.

Most of the programming languages in use (BASIC, COBOL and FORTRAN) are based on this concept of a program.



High-Level languages

A program is a sequence of instructions which may be executed in a certain order. On a computer which does not offer any software aids to the programmer, it is possible to program only using binary numbers, the so called "machine language'. It is not only tedious to write a program in this way, but also extremely difficult to diagnose any errors that may creep in. Also, if all programmers were to use only machine language, no software present in the machine is safe. If every memory location is accessible to a programmer, a program could thoroughly mess up any other program or data present in the computer memory As for debugging, the programmer will have to keep track of large portions of memory too. That is, he/she has to follow the state of the computer too rather than just the state of the program.

Most computers, however, come with a certain amount of software. An operating system is usually available to allocate memory space to each program and safeguards the system by not allowing programs to access certain crucial memory locations. So a programmer needs to keep track of only the program state A few compilers are also usually made available. They permit the programmer to write programs in a more easy-to-understand English-like language. Such languages are called *high-level languages*. The language described below is precisely one such.

The quintessence of QPL

Essentially, QPL consists of the assignment, the skip, the input and the output statements, as the simple statements (SCIENCE TODAY, June, 1984). The assignment and the input statements are used to change the program state by changing the values of the variable in the program. The input statement is the means by which the user changes the state during execution. The output statement is used to inform the user of the results obtained. The only other statements in QPL are the compound statements—the conditional and the loop.

The conditional statement is used for making a decision based on the current state of the program

Most programming languages allow some form of this statement. In certain languages the statement has the form

IF condition THEN statement

without having an ELSE-clause. The effect of the ELSE-clause, however, may be achieved by other means.

Note that the if-statement of QPL is really made up of the two statements, one immediately following the word 'then' and the other following the word 'else'. Such statements are called *compound statements.* There is no restriction on the kinds of statements that compose the if-statement. Each of them could be a compound statement by itself. In fact, any two statements separated by a semi-colon could be regarded as forming a compound statement. We enclose the constituent statements of the if-statement and the while - statement (which we will shortly describe) within braces so that the entire constituent may be treated as one single instruction.

The following algorithm makes the point clear

```
{IF there is bread
 THEN have sandwiches
 ELSE {IF the neighbour is good
        THEN {drop in for tea}
        ELSE {borrow some money}}}
```

Looping and its variations

There is only one statement left from QPL that we have not discussed—the while statement. All the statements we have seen so far *always* terminate. In fact any program written using only these will always finish execution, however long or complicated the program itself may be.

It frequently happens that in order to achieve a certain end result a few steps have to be repeatedly executed several times. For example, consider the following program to find the sum of the numbers from 1 to 100.

```
Program "Sum 1 to 100 version 1"
{Sum←0;
  I←1;
  WHILE (I<101) DO
   {Sum←Sum + I;
    I←I + 1};
Print ("Sum of the first 100 natural
numbers is", Sum)}
```

In this program initially I=1. So the

An endlessly falling water column (?) The concept of a strange loop beautifully illustrated by the Dutch graphic artist M.C. Escher

statements after the word "DO" and enclosed within "{ }" will be executed till I=101. Each execution of the statements within a while loop is called an "*iteration*". Suppose we had forgotten to write the statement "I←I+1". The while statement would then be executed forever! That is what we mean by saying that a program need not terminate but an algorithm has to

But in many problems the condition for termination is known For example, in the program above exactly 100 numbers were to be added. In such cases, it is more convenient to use what is defined as a for statement. The above program would then be

```
Program "Sum 1 to 100 version 2"
 {Sum←0;
  FOR I←1 to 100 DO
   {Sum←Sum + I};
Print ("Sum of the first 100 natural
numbers is", Sum)}
```

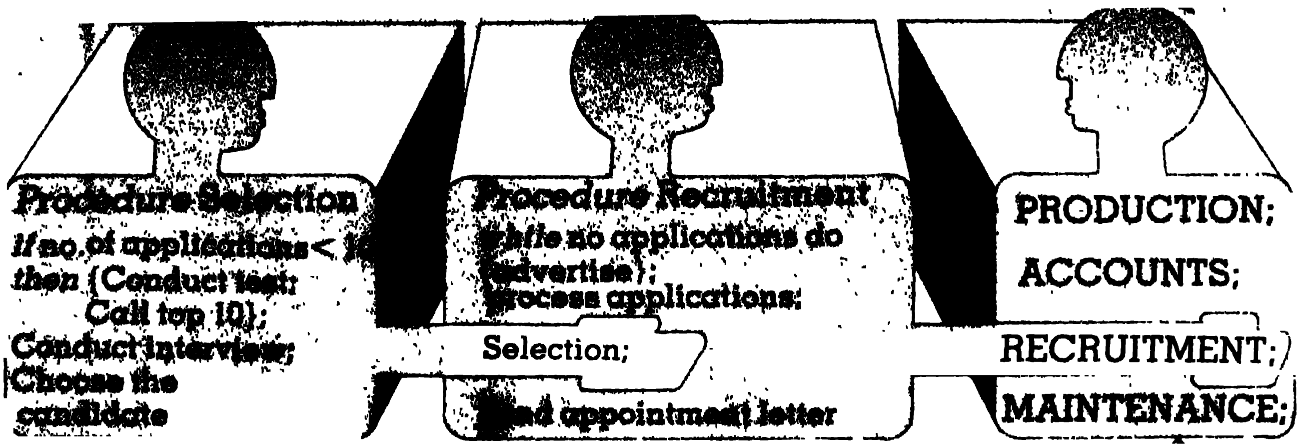
Suppose we wanted to find only the sum of *even* numbers between 1 and 100 (inclusive). Using a minor variation of the language we could write:

```
Program "Sum of even numbers"
  Evensum  ←0
  FOR I←2 to 100 STEP 2 DO
   {Evensum←Evensum + I};
Print ("Sum of the even numbers
between 1 and 100 is", Evensum)}
```

The word 'step' indicates by what

continued on page 51

"Drawing hands" by M. C. Escher. Where is the beginning and where is the end?



Activities of an organisation represented as procedure calls

continued from page 49

amount I should be increased for each iteration. Here I can take the values 2, 4, 6 etc up to 100. Can you guess what would happen if the 100 in the for—statement above were replaced by 101?

Most modern languages allow both while and for statements. In fact several variations of these are provided to enable the programmer to express the program as conveniently as the problem dictates. But in some of the older languages, notably FORTRAN and BASIC the only method of iteration is by means of the for statement (called the "DO statement" in FORTRAN) In fact the while statement is more general, in that it allows a programmer more freedom, but at a premium, namely the risk of non-termination. For example, the program for substituting the word 'bloody' by '****' (below), could not have been programmed easily by using just the for statement. Of course, FORTRAN and BASIC do allow other statements with which such problems can be programmed, but the programs thus written are generally not as clear as the programs written in QPL, PASCAL, ADA etc

```
Program "Substitute";
WHILE not end of "TEXT" file DO
{Read from "TEXT" (word);
  If (word = "bloody")
  Then {Print into "NEW TEXT" file
  "****"}
  Else {Print into "NEW TEXT" file
  (word)}}
```

The variable here is word The actual characters are distinguished from the variable names by enclosing them within quotation marks

Programs within a program

We have already pointed out that, often, a large problem cannot be tackled at one go. It becomes necessary to break it up into a number of smaller problems (sub-problems). Each of the sub-problems is solved and the solutions are all put together to yield the solution to the large problem. This, in fact, is the main idea even in school geometry. Often a theorem is not directly proved. A number of smaller theorems called 'lemmas' are first proved and the theorem is then proved with the help of these. One obvious advantage of breaking up a problem into several sub-problems is this it is quite likely that someone has already solved one of the sub-problems in connection with an entirely different problem As an example, say, you want to write a program to find the standard deviation of several numbers. One of the sub problems you need to program is for squaring a number Suppose some one has devised a program to find the value of pi (to several digits) by the series expansion method

$$\pi^2/6 = 1 + 1/4 + 1/9 + 1/16 + \ldots$$

which also requires to find the square of a number Then the easiest thing for you to do is to copy this part of the program for your job. But it may not be always easy to do this You may have to make several changes to suit your problem

But, perhaps, the most important advantage of writing large programs in this manner is that to understand the program (possibly in order to debug it) it is usually necessary only to know what each subprogram does and not how it works. In diagnosing a faulty program, the error can usually be pin-pointed to some particular procedure If a car does not stop when the brakes are applied, the mechanic will at once check the brakes and the brake-linings. If the car cannot be reversed, then something is wrong with the gear system and not the engine or the steering.

A program usually consists of several sub-programs (they are also called "procedures") and a main-body. The main-body performs the task of putting the various solutions together. While debugging a program, it is necessary to find out what each procedure does and check that the main program is correct under the assumption that every procedure is correct with respect to its specification If the main program is found to be correct then you try to guess which of the procedures could have an error.

Procedures are used to separate logically different activities and maintain the clarity of the program. Every programming language supports procedures Without them it would be very difficult to write really large programs.

Recursion

Do you know the secret of living to be a hundred? It is quite simple. First live to be 99 and then be very, very careful during the next 12 months An example of recursion--got it?

If not, consider this suppose you have a book of 1,000 pages and are trying to get to page 274 This is how, probably, you would go about it.

(1) open the book randomly at page p, between 1 and 1,000

(2) if p>274 then repeat the above process for pages 1 to p-1, otherwise, if p<274 then repeat the above process for pages p+1 to 1 000

otherwise, you are at the right page

What have we done here? We have, essentially, solved a problem in terms of a smaller version of the same problem If you had only page 274 in your range the problem is trivially solved. Many problems and definitions in mathematics are recursive. An example

of this is the factorial function

What is meant by factorial is this factorial $5 = 5! = 1 \times 2 \times 3 \times 4 \times 5$

A neat way of defining this function is

```
if (x=0) then x! = 1
else { if (x >0)} then
  x ! = x * (x-1)!
```

Try programming this with a simple FOR statement
(It is not always easy to program such problems with a FOR or WHILE statement).

Most modern programming languages allow for recursion as it forms a natural way of expressing certain operations. Moreover, it is also heavily used in mathematics. No doubt, a program could be written without recursion, but it will involve adding several new variables. Secondly, the transformation from a recursive program to one without it is not automatic and ways and means of achieving it are still under way.

Fortran or Cobol?

We have presented the structure of QPL because it expresses the quintessence of programming languages There

"Hand Reflecting a Globe" by M. C. Escher. An elegant expression of recursion

are hundreds of programming languages, mostly based on the concepts we have exposed using QPL. The differences between any two of them is more apparent than real (at least for small and moderate-sized programs).

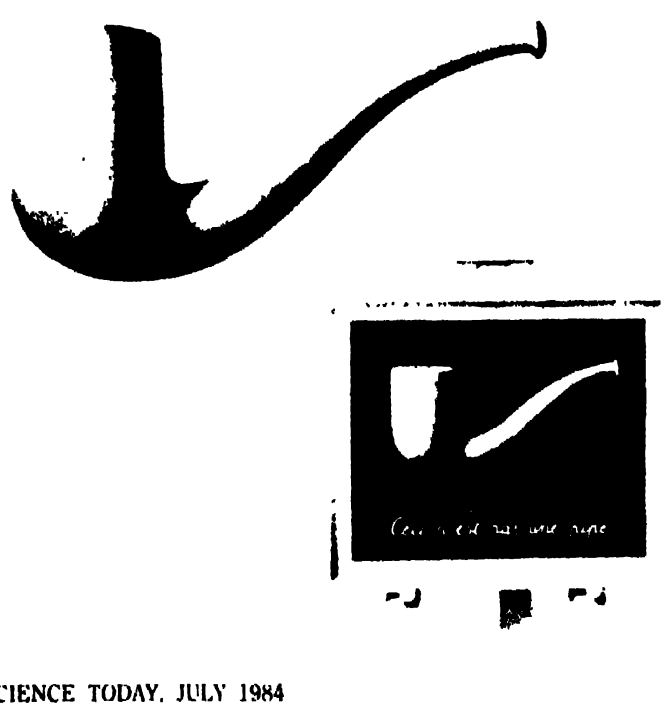
Yet the reader could quite justifiably ask. 'If all programming languages are really the same, except for minor changes (as in dialects), why do we hear that FORTRAN is good mostly for scientists, COBOL for data processing and so on and so forth?' The answer is straight forward. If you wish to write scientific programs in COBOL, go ahead by all means. Data processing is also possible with FORTRAN But once you start doing it, the difference becomes evident. The preference for one or the other language is due to the vastly different support facilities the two languages offer you.

We elaborate on this point through an example. COBOL for instance, has a built-in report-writer facility. In business problems, along with the processing of data it is usually necessary to prepare reports in certain specified formats. Since this activity is a necessary part of the environment, the designers of COBOL have thoughtfully provided a facility for preparing such reports, as an integral part of the language However, such a facility could equally well be programmed in any other language So a report-writer, if needed with FORTRAN, will have to be explicitly programmed It is a waste of time and effort as it is already available in COBOL

Similarly FORTRAN offers a library of subprograms with trigonometric functions, logarithms, high-precision arithmetic, and various other facilities which are useful for scientists and engineers. APL is used by engineers who have to deal with large matrices and operations on them, because it provides these facilities as an integral part of the language However, as we have already said, each of these support facilities can be programmed in other languages as well.

But the situation is different for very large programs (containing more than 10,000 lines). The concept of procedures is found to be insufficient for their development necessitating new concepts There are several problems which cannot be conveniently expressed in terms of program states (though, it is certainly possible). For such cases, new programming concepts—other than the program state—have evolved. But that is quite another story. □

The pipe in a twice-nested painting somehow looks less real by Rene Magritte



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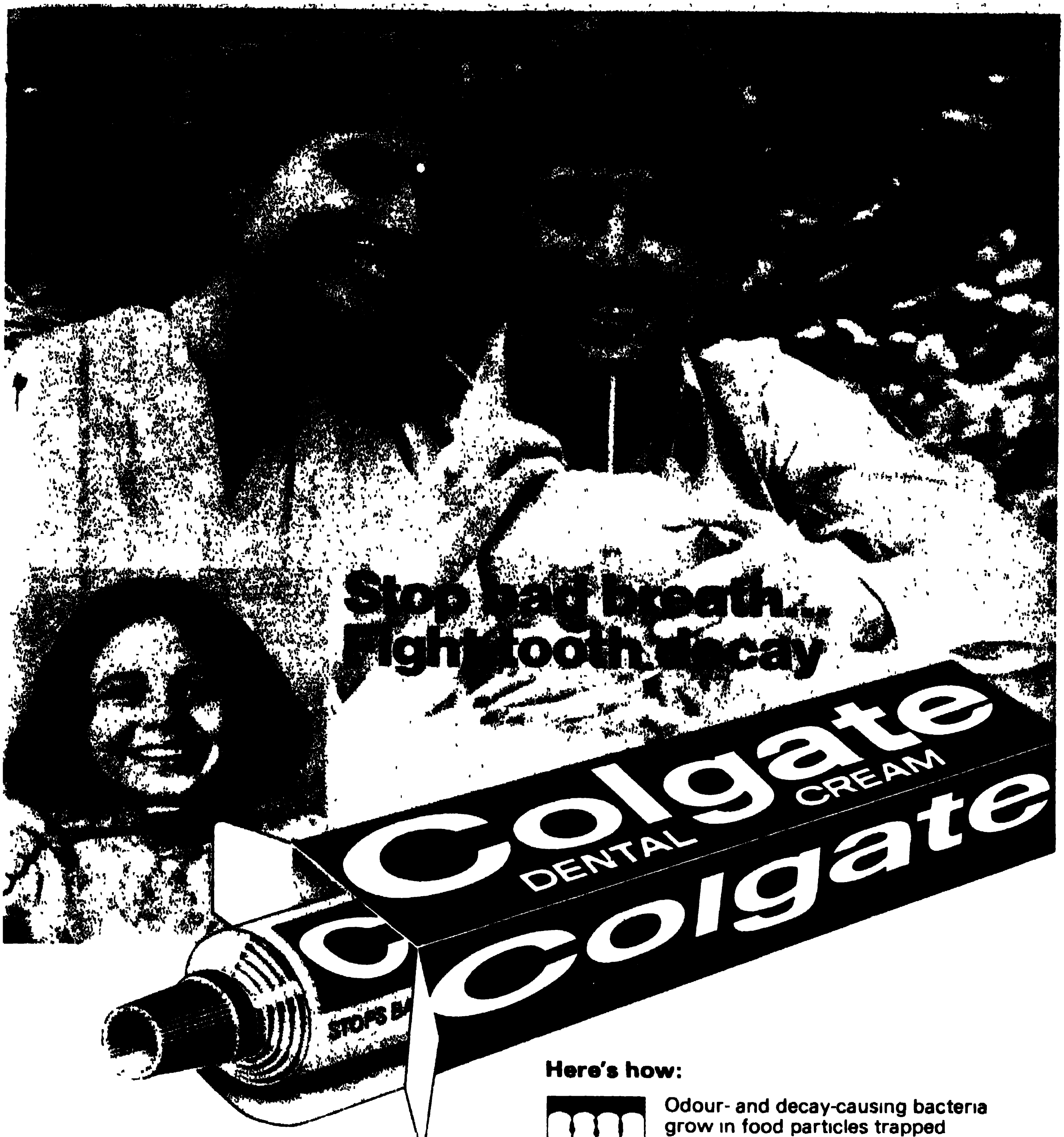

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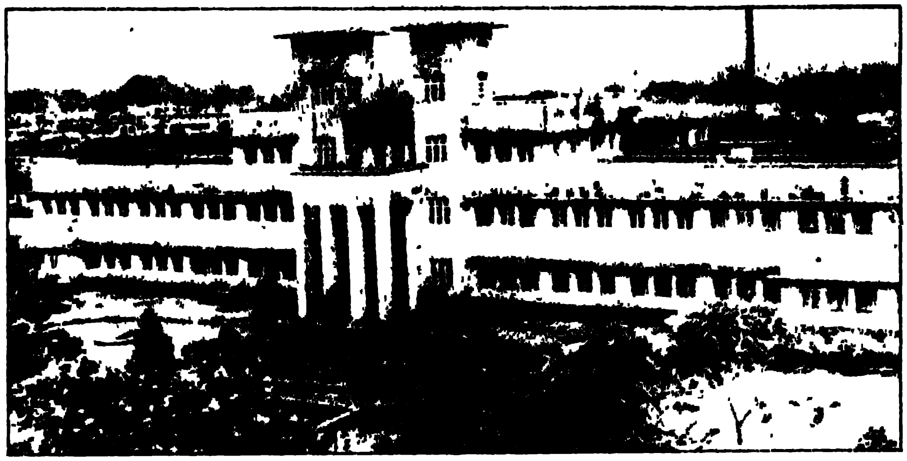
*"The Cloister's Pale: A Biography of the University of Bombay." By Aroon Tikekar. Somaiya Publications, Bombay. Price Rs. 200

In the year 1857 — the *annus tristis* — the hopes for the liberal English education for Indians materialised with the setting up of the University of Bombay. In many ways the rise of Bombay as a great modern metropolis parallels the growth of the University which has been portrayed by Dr. Aroon Tikekar, Reference Chief, *The Times of India* Group of Publications, in an informal history*. Dr. Tikekar has drawn upon a wide range of source material and splendid old photographs of the city and its University.

We present an excerpt on the setting up of the Royal Institute of Science and the University Department of Chemical Technology from this fascinating book which is bound to be welcomed by social historians



The UDCT building in Bombay

IF Sir Richard Temple had successfully introduced a special degree in Science in the year 1882, Lord Sydenham had shown an equal interest in the development of the teaching of science The Royal Institute of Science was basically his idea He had made an appeal for help for the study and teaching of science in the University of Bombay The appeal met with instantaneous success In Ahmedabad Sir Chinubhai Madhavlal the first Baronet, made liberal provision for the establishment of the Madhavlal Ranchodlal Science Institute In Bombay, a number of donors came forward to support the cause and realised Lord Sydenham's dream and so was established the Royal Institute of Science within the Cowasjee Jehanghier Hall In all Rs 25,75,000/- were collected for the Institute and Rs 3,00,000/- for the Hall, out of which the contribution of J Cowasjee Jehanghier the son of Sir Cowasjee Jehanghier was Rs 4,00,000 for the institute and a separate donation of Rs 1,75,000 for constructing and equipping the Hall which bears his name He further donated a sum of Rs 75,000 for its maintenance Sir Jacob Sassoon donated Rs 10,00,000 while Sir Currimbhoy Ebrahim donated Rs 4,50,000

Sir Vassanji Tricumji gave Rs. 2,25,000 for building a library for the Royal Institute The share of the Government of Bombay was Rs 5,00,000

The building of the Institute although ready, could not be used by the Institute for some years it was fitted up as a Hospital and was called the General Freeman Thomas Hospital for the soldiers wounded in World War I. The Institute along with C J. Hall was formally declared opened on 27th March, 1924 Many members of the University wanted the Institute to be conducted by the University as a post-graduate department for study and research in Sciences In pursuance of a resolution of the Syndicate, Sir Chimanlal, the Vice-Chancellor addressed a letter (3rd July 1919) to Government placing before them the ideas of the University The decision of the Government on this issue was deferred for long Instead of accepting the University's suggestion, the Government in December 1920, applied to the University for affiliation of the Institute for the B Sc degree

The Senate at its meeting on 19th August 1922 refused affiliation and passed the following resolution -

"That Government be informed that the Senate is strongly of the opinion that an Institution so liberally endowed as the R I S should primarily be a post-graduate Research Institute affording ample facilities, both pure and applied, and providing adequate instruction for such graduates in Science as desire to obtain the M Sc degree of the University by reason of original work of a high order or by submitting to the prescribed examination, and also for others who from pure love of science, wish to do research work without any intention of proceeding to a degree

That the University may at an early date be entrusted under proper safeguards with the management control and direction of the Institute that it may fulfil its natural function and be favoured with as liberal government contributions as the University College of Science, Calcutta "

The Government of Bombay, in a letter dated 8th November, 1922, accepted partly the recommendation of the Senate As regards its control by the University, the Government argued that

"the donors of the endowments of the Institute have recently communicated to Government their express desire that at no time in future should the control of the Institute be transferred to the Bombay University or to any other body "

The University had no choice but to grant affiliation to the Royal Institute This it did in 1925, initially for five years but not before reiterating that the main functions of the Institute as a place for research work and advanced science teaching would be kept constantly in view And it has done so till today

THE University next took up the matter of a school of Chemical Technology A Committee was appointed in 1921 with Sir M Visvesvarava as Chairman, to consider the extension of technological education in the Bombay Presidency The Committee recommended that the Faculty of Technology be instituted in the University of Bombay and that a College of Technology be established in the city of Bombay Another thirteen years had to elapse till the Department of Chemical Technology was started and another eight years to lay the foundation stone of a building of its own Sir Roger Lumley, Governor of Bombay laid the foundation-stone on 17th March, 1941. Several donations amounting to Rs 30,70,000/- from various donors had been received by the University, Sir Homi Mehta alone contributing Rs 7,00,000/- Through the efforts of Sir Vithal Chandavarkar, the University secured for the Department Rs. 4,03,000/- from the Bombay Millowners' Association.

SWEET DREAMS

Our life is two-fold: Sleep hath its own world,
A boundary between the things misnamed
Death and existence: Sleep hath its own world
And a wide realm of wild reality.

—LORD BYRON, from "The Dream" (1816)

VIJAY BENDRE

WHO does not know the "wide, wild realm" of sleep? Night after night, swaddled in dumb dark, we drift into this "two-fold" world, on a soporific sojourn that occupies a full third of our lifetime.

Sleep has a two-fold character in more senses than one. Periods of light and deep sleep alternate with some regularity approximately every one hour and a half During these light sleep intervals the eyeballs move behind closed eyelids, as if watching something The muscles of the middle ear are contracted as if listening to something Also, the brain shows signs of intense activity This is the so-called REM sleep (after rapid eye movement which is its salient character)

It has now been established that most of our dreaming activity occurs during REM sleep, in which the highly visual, intuitive right half of the brain is freed from the dominance of the rational left half

Says one sleep researcher "If it were not for the operation of inhibiting mechanisms in the brain during REM sleep, we might act out our dreams . It is probably our good fortune that our muscles cannot respond to all those visual cues exploding across the brain " Imagine indeed chasing that luscious nymph into that scarlet wood Imagine trying to ride all those wishes, or running away from the fiends, those werewolves which sometimes materialise into our nightmares' But that does not answer the question *why* we dream?

Theories of dreams abound The latest one from Francis Crick and Grahame Mitchison, (SCIENCE TODAY, January 1984) says that dreams are a sort of a debugging operation carried out by the human computer to rid itself of glitches or potentially harmful associations. According to this theory then, recalling your dreams does you no good at all Psychoanalysts, are you listening? Even if you are not, does not matter For recalling, even recording, of dreams has been going on for thousands of years —long before Freud's entry into the world! And this interesting activity is likely to continue unabated despite what Crick may have to say. Can you forget that lovely dream lunch with your favourite friend? Nor can you forget that nightmarish night in the harem But jokes apart, the record of dream experiences does make fascinating reading This is provided by Stephen Brook in his anthology of dreams. You have a veritable bank of dreams here to draw upon, and that too dreamt by a veritable who's who. Here is a random sample. Don't close your eyes'

EVELYN WAUGH 'Vodka gives one marvellous dreams I have discovered, but prevents one from sleeping *(sic)* Every night lately I have dreamed luxuriously but slept ill '

ROBERT HERRICK "I dream'ed we both were in bed/Of roses, almost smothered The warmth and sweetness had me there/Made lovingly familiar.

WILLIAM HAZLITT "I never dream of the face of any one I am particularly attached to '

ASTRAMPSYCHUS "To be dead (in dreams) announces freedom from anxiety '

GEORGE SANTAYANA 'Nothing could be madder, more irresponsible, more dangerous than this guidance of men by dreams

Stephen Brook has drawn on diverse sources to compile his readable anthology But as he makes clear in the introduction, his book does not contain many examples of dream interpretation most of the dreams in the book are instances of the literary exploitation of the dream experience Says Brook, '(Because) dreams are regarded as beyond our conscious control they are often made in literature to convey information or desires that, if overt, might be regarded as preposterous, psychologically inadmissible or in some other way subversive of our sense of normality Unpinned even by rudimentary notions of time and space, dreams float or flash by, leaving in their wake trails of unease, hopes, fears, and anxieties. It is scarcely surprising that these uncontrollable companions of our sleeping hours offer a rich resource to the poet or novelist, for the very absence of rules that characterises dreams means there is no limit to the possibilities of invention and signification at the writer's disposal "

For all its unruly nature, Brook has imposed some order upon his "dream material" The book is divided into three parts. The first part dwells on "the great inescapable experiences' that are common to us all childhood, love, sex and finally death. Part two contains not so much the grand themes of living and dying as the more tangible features of the world around us food, animals travel and the natural world creativity, violence and happy endings The final section tries to come to terms with the very peculiarity of the dream experience, the headings of the subsections are likely to give some idea of the material. "Into Sleep 'Nightmare , 'The Absurd", "Transformations and Frustrations', 'Interpretations , and finally "Waking

Whichever section you choose to browse in, you are bound to find something to illuminate, to tantalise, to perplex and to delight your mind "Traveller repose and dream among my leaves says William Blake at the beginning of the prologue to the book which seems destined to become a classic I would only change the *traveller* to *reader* Happy dreaming'

Vithal C. Nadkarni

The Oxford Book of Dreams
Chosen by Stephen Brook; Published by Oxford University Press;
Price £8.95.

Is lithium a new incarnation of the dwarf god Wamana to push down mighty King Balis of today?

Resources for tomorrow

IN the early days of August 1945 the savage bombing of Hiroshima and Nagasaki brought an end to the hostilities of World War II. The Americans were naturally jubilant. They now enjoyed an undisputed monopoly over the most destructive weapon ever devised by mankind. But this euphoria was short lived. In August 1949, barely four years after the dropping of the first atom bomb, American aircraft brought with them incontroversible evidence of an atomic explosion somewhere in Soviet Asia. The Americans reacted to this event in a predictable manner. Joe I, as the Russian bomb was nicknamed, would have to be trumped by a 'Super' bomb. Work in this direction was immediately initiated under the leadership of Edward Teller. The first 'Super' was successfully exploded in November, 1952. The device was based on the thermonuclear reaction between deuterium (D) and tritium (T), the two heavier isotopes of hydrogen.

Since tritium had to be maintained at a very low temperature by means of a rather heavy freezing apparatus, the whole contraption weighed about 65 tons! Efforts were therefore immediately on for the production of a lighter version. The crucial 'candidate' for this purpose was lithium. Here again the Russians sprang another surprise. In August 1953, they already carried out the detonation of a dry bomb based on a lighter isotope of lithium and the race was on! The lightest metal thus made possible the construction of the mightiest weapon, a 20 megaton hydrogen bomb -a thousand times more destructive than the first atom bomb! Is lithium a new incarnation of the 'dwarf' God Wamana to push down into oblivion mighty King Balis of today?

Strangely enough lithium salts are also finding use in an altogether different area - in curbing maniac depression of psychic patients.

Discovery and extraction

Lithium was discovered in 1817 by the Swedish chemist Arvfedson. His repeated attempts for the complete analysis of the mineral petalite invariably led to a total of 96 per cent and no more! The only plausible solution to his dilemma was obvious. He had discovered a hitherto unknown element which was responsible for the missing part in his complete analysis. Unlike its close relatives sodium or potassium which were first discovered in the plant kingdom, lithium was found in a mineral and therefore, at the suggestion of his boss, Berzelius, Arvfedson named it lithium (from the Greek word *lithos* meaning stone). It was much later, in 1855, that the pure metal was isolated by Bunsen in Germany and Davy in England by the electrolysis of fused lithium chloride.

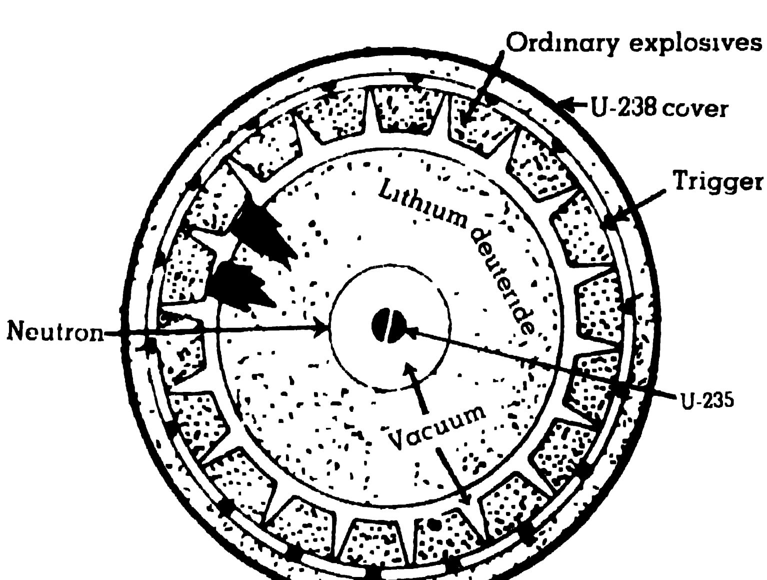
Lithium is the first in a series of highly reactive group of elements called the alkali metals. But it is much less abundant than its next two congeners sodium and potassium.

The most common lithim ore in North America is spodumene ($LiAlSi_2O_6$). Substantial quantities of lepidolite ($LiKAl_2F_2Si_3O_9$) and petalite ($LiAlSi_4O_{10}$) are found in Rhodesia. Ambligonite ($LiAlFPO_4$) deposits exist in Europe and South America.

In the alkaline process of extraction, the ore is ground and calcined with about three parts of limestone to one part of lithium ore at 900-1000°C. Water leaching of the product yields lithium hydroxide which is converted to the chloride by reaction with hydrochloric acid.

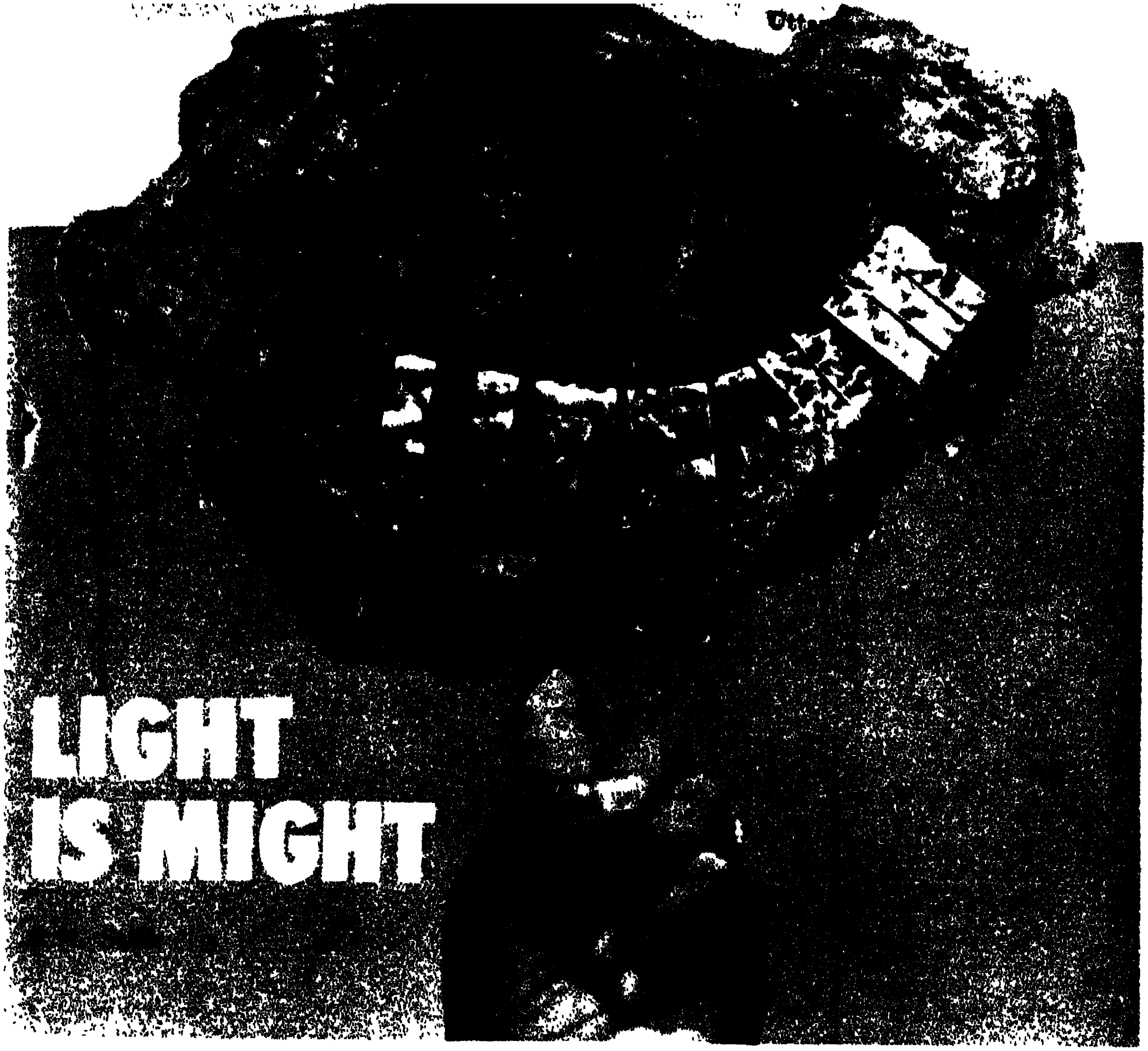
Dry lithium chloride is the feed material for winning the metal by the electrolytic process. A molten mixture of lithium and potassium chlorides is

Hydrogen bomb



The core of the hydrogen bomb consists of a subcritical mass of the fissionable isotope of uranium U-235. It is surrounded by a blanket of lithium deuteride. This is separated from a ring of high explosives by an evacuated space. The detonation of symmetrically arranged chemical explosives sets out a compression wave and makes U-235 assembly critical. The explosion of the fission bomb creates the high temperature necessary to initiate the thermonuclear reaction in lithium deuteride. The fast neutrons accompanying the fusion energy release, bring about fission of the U-238 shield compounding the explosion energy to the megaton range.

R.M.S.



electrolysed at a voltage of 8-9 volts and at a temperature of 400-420°C. The metal collects at a steel cathode encased in an iron gauze diaphragm.

Lithium is a soft silvery metal, much lighter than water and highly reactive.* It can combine with oxygen and nitrogen (two major components of air) at room temperature. The initial problem was therefore to confine this boisterous kid in a suitable cradle. If kept in a glass vessel with a stopper, it readily combines with the air present creating a vacuum. Then the only way to open the stopper would be to break it. Like its elder brother, sodium, lithium cannot be kept submerged in an inert liquid like kerosene. Due to its lightness, it can pop up to the surface and burn. The only way of keeping it under restraint is to embed it fully and firmly in paraffin wax.

Lithium, because of its softness and reactivity has practically no utility as a structural or engineering material. Its compounds, however, find innumerable uses in industry and laboratory, as well as in a variety of fields having to do with submarines to automobiles to rockets[1]

Light is might

Lithium and its compounds owe many of their applications to their lightness which results in a higher yield per unit weight. For example, lithium hydride is used as a portable source of hydrogen. One gram of lithium hydride would produce 2800 ml of hydrogen. A small pellet of the hydride on contact with water instantaneously releases sufficient hydrogen to inflate rescue facilities such as inflatable boats or life jackets.

Lithium perchlorate has been suggested as an oxidiser for solid propellant rocket mixtures since it can offer a higher percentage of available oxygen than any other perchlorate. Lithium is also a strong contender as a rocket fuel material. The normal rocket fuel is good old kerosene and has a calorific value of 2,300 kCal per kilogram, whereas lithium is capable of releasing 10,270 kCal for each kilogram. A homogeneous propellent made by dissolving ethyl lithium LiC_2H_5 in conventional hydrocarbon fuels promises better performance than that of pure metal.

Unhydrous lithium hydroxide is an efficient absorber of carbon dioxide and is used for atmosphere regeneration in

submarines. Lithium halides form concentrated brines having the ability to absorb moisture over a wide temperature range and are used in commercial air conditioning systems

Alkaline storage batteries (Edison cells) use sodium or potassium hydroxide solutions as the electrolyte. Small additions of lithium hydroxide to the electrolyte increases the battery life to over three times. These batteries also remain serviceable over a wider temperature range (+40°C to −20°C).

Lithium based secondary cells are coming into prominence as batteries with high specific energies, which make them ideal for vehicular traction or stationary storage. A cell based on a molten eutectic of lithium and potassium chloride and electrodes made of a lithium aluminium alloy has an energy density of about 400 Whr/kg as against 15 Whr/kg for the common lead acid battery. The former, however, require a much higher temperature of operation (~ 400 °C).

Lithium is very valuable in making superior quality porcelain. Lithium ceramic materials have very high heat resistance and are used in coatings for rocket nozzles and combustion chambers to protect them from damage caused by the high energy lithium rocket fuel described earlier. Yet another case of setting a thief to catch a thief!

Due to its small size, lithium ion has a high polarising power. Lithium ion so strongly polarises its co-ion, that there is an appreciable electron density between the nuclei resulting in a bond largely covalent in character. Thus LiCl is more covalent and soluble in non polar solvents compared to other alkali chlorides. Lithium thus forms a large number of alkyls where lithium is directly bonded to carbon. These covalent organometallic compounds exist as liquids or low melting solids, soluble in organic solvents and are extremely useful as homogeneous catalysts in the stereo specific polymerisation. It can thus polymerise isoprene to cis polyisoprene which is the exact structural counterpart of natural rubber where all the methyl (CH_3) groups in

Lithium is a strong contender as a rocket fuel material

the monomer stick out in one direction only.

Another important lithium compound is lithium aluminium hydride, soluble in ether and useful for reduction of a wide range or organic compounds—aldehydes, ketone, ester and acids—to the corresponding alcohols. The advantage is that it does not touch the double bonds in the original compound and gives very good yields. One such important reaction is the reduction of vitamin A to acid vitamin A.

A compound of major industrial importance is lithium stearate used as a thickener for lubricating greases. The lithium based lubricants enable vehicles to operate even in polar regions where temperatures are as low as −60°C. Futhermore, once applied they can last to the end of their service life. These all-purpose greases have captured above one third of the total automotive grease market. It must however be remembered that all lithium salts are much more costly than the corresponding sodium or potassium salts.

Fusion energy

The discovery of radioactivity sparked the hope of harnessing nuclear energy for our benefit. The hope was further reinforced by the development of particle accelerators. The high energy projectiles emerging from these machines could initiate nuclear reactions which are accompanied by large energy releases. The first such promising reaction involved the lighter isotope of lithium, Li-6 (See fig. 1)

An accelerated deuteron of 20 KeV could bring about this reaction producing in the bargain 22.5 MeV, a thousand fold gain! The only snag was that only one in about 10^6 high energy deuterons was successful in reacting with lithium

The second world war witnessed the emergence of nuclear energy in its devastating form. The energy released in atomic fission was later harnessed in nuclear reactors to produce useful electrical power. Fission energy has however proved to be a high risk energy because of intensely radioactive fission products produced as a by product. The next attempt was directed towards taming the much greater energy of the hydrogen bomb, the so-called fusion energy released in thermonuclear reactions as happens in the Sun and the stars. Advent of controlled fusion energy is described as an uncertain certainty. It is certain to come but it is uncertain as to when it would

The reactor concept for usable energy release from a controlled thermonuclear reaction is based on the deuterium—tritium (D-T) reaction because of the lower temperature necessary for its ignition (See fig 2).

The tritium required is neither available in nature nor can be manufactured in quantities needed. D-T power reactors will then be required to breed tritium (like polutonium in a fission reactor). It is here that lithium plays the key role as a breeder. Natural lithium has two isotopes Li-6 (7.4%) and Li-7 (92.6%). Li-6 can react with a

Flame photometer

Lithium salts impart a bright scarlet colour to a flame. The thermal energy of the flame excites the 2s electron to the higher 2p state, which, while returning to the original state, emits a characteristic radiation at 671 nm. The intensity of this radiation is a measure of the concentration of lithium. This method enables us to estimate as low as 3 x 10 ug of lithium per ml. The instrument used for the purpose is called a flame photometer. A solution containing traces of lithium is aspirated into a flame at a constant rate. The light emitted by the flame is passed through a prism to isolate the wavelength of interest. Radiation of the specific wavelength falls on a phototube. Here the light intensity is converted to an electrical current which is measured by a sensitive galvanometer. The galvanometer deflection is directly proportional to the concentration of lithium in the sample solution.

R.M.S.

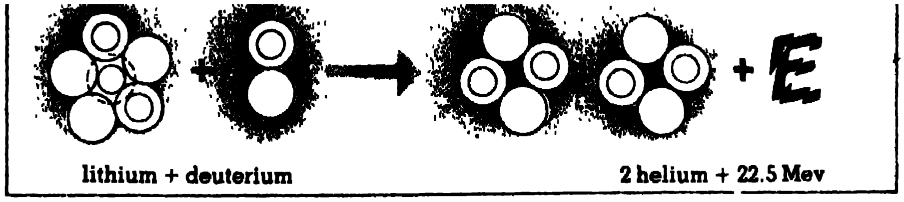


Fig. 1

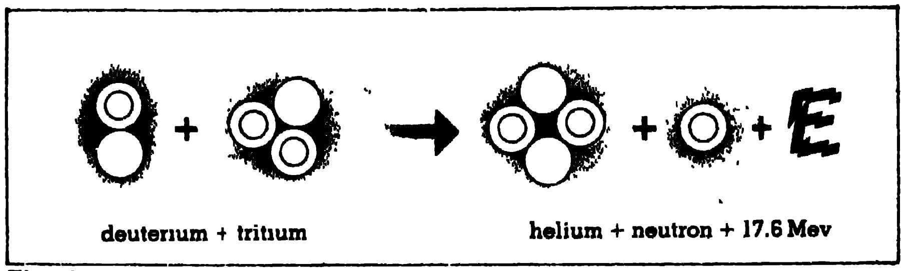


Fig. 2

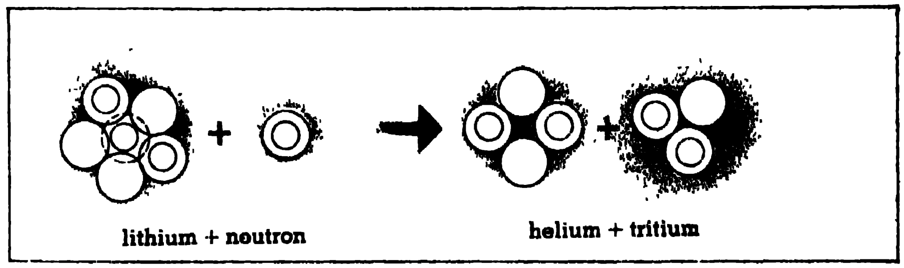


Fig. 3

thermal neutron with a high probability to yield tritium (See fig. 3)

Tritium produced fuses with deuterium releasing large amounts of energy and a neutron which can react with lithium-6 as shown in the above reaction and sustains the chain reaction. Because of the large relative mass difference enrichment of lithium-6 is not likely to be a very difficult task.

The use of pure lithium (or its compound or alloy) as a blanket material has been the central idea in virtually all D-T reactor design studies. In addition, liquid lithium or some molten lithium salts which have favourable heat characteristics offer the possibility of combining both blanket and coolant functions (liquid lithium has the largest temperature range). The free world reserves of lithium amount to 2.2×10' tons If fully and efficiently used, they would satisfy our energy needs for another 2000 years

Lithium is also very thinly distributed in sea water (170 μmg/litre) and in granitic pegmates. If, in the meantime, we succeed in, extracting lithium from these practically inexhustible sources the world need no longer worry about its energy requirements for all times to come.

Lithium is considered as a non-essential trace element which fulfils no known biological function in the human system, but for a long time lithium has been used in medicine as an antidote for gout. In large amounts lithium is toxic being even fatal at times. But smaller doses orally administered have been found useful in preventing or reducing manic-depressive disorders in human beings. About one gm of lithium carbonate is administered daily in such cases and is raised to about 1.8 gm for acute cases. The treatment has to be accompanied by continuous monitoring of plasma lithium levels (10 to 15 μg/litre). An increase in this level will bring about toxic effects like tremors, diarrhoea and vomitting Lithium in blood plasma can be rapidly and easily estimated by a simple spectroscopic technique (see box on p 58).

Lithium occurs as a trace constituent in different articles of food. Large amounts are present in tabacco leaves and crude sea salt and mineral waters. The daily intake of lithium in Indian population has been found to be between 75—150μg as against 45μg for people in the west. The low incidence of manic depressive psychosis (MDP) in India may be related to the higher intake of lithium through the above routes. Tobacco chewing may cause oral cancer but then you don't have to worry about MDP!

In our country lithium occurs in the form of lepidolite and is confined to the pegmatitic bodies in the mica fields of Bihar, Rajasthan and Madhya Pradesh. Bastar district in Madhya Pradesh has several hundred tons of this ore of 2.6 per cent LiO_2 content.

Under the Atomic Energy Act 1962, lithium has been declared as a prescribed material useful for atomic energy and the sole rights of exploitation of processing lithium minerals vest with the Atomic Minerals Division— a constituent unit of the Department of Atomic Energy But the export of lithium ores has now been decontrolled. The knowhow for processing these ores to obtain lithium as carbonate has been developed by the Bhabha Atomic Research Centre, the Central Glass and Ceramics Research Institute and the Central Salt and Marine Chemicals Research Institute A couple of private firms also produce lithium carbonate on demand for commercial use. Most of our present requirements for other lithium compounds are entirely met by imports □

Dr Sathe is with the Analytical Chemistry Division of the Bhabha Atomic Research Centre, Bombay He also teaches analytical chemistry to post graduate students of Bombay University and is a visiting professor of SNDT Women's University in Bombay

▸ ***Lithium aids thermonuclear fusion***

DHANANJAY SASTAKAR

GOLIATH'S KILLER

S N KULKARNI

Sling and its principle was known to man from earliest times. Based on it, the ancient armies built powerful catapults. Even today the same principle is used to launch aircraft, missiles, etc.

"Then he took his staff in his hand, and chose five smooth stones from the brook, and put them in his shepherd's bag or wallet; his sling was in his hand, and he drew near to the Philistine

When the Philistine arose and came and drew near to meet David, David ran quickly toward the battle line to meet the Philistine. And David put his hand in his bag and took out a stone, and slung it, and struck the Philistine on his forehead; the stone sank into his forehead, and he fell on his face to the ground

So David prevailed over the Philistine with a **sling** *(emphasis added) and with a stone." (1 Samuel 17· 40-50)*

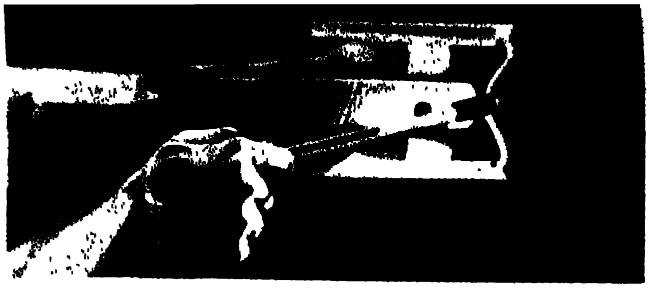
SLING is one of the most primitive, probably the first weapon designed by man. In the process of evolution man encountered enemies stronger than himself. To overcome them he had to invent means to propel rocks or other missiles with more force than his hand and arm could deliver. The sling proved to be his saviour.

In its oldest form, a simple sling consisted of a pocket or strap, usually made of leather or hide with a string fastened to each of its end. A stone or any other missile was placed on the strap. One string was looped over the fourth finger, and the other was held between the thumb and forefinger. The operator whirled the sling above the head, let go the unlooped string and released the projectile. The centrifugal force gained in the whirling action gave power and range to the shot.

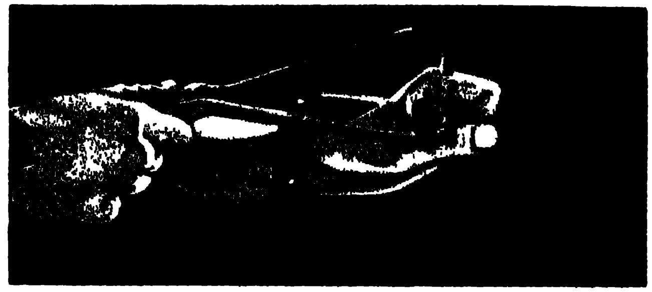
The principle of the slingshot was made use of by the ancient armies of Egypt, Greece and Rome to build catapults. The first catapult is attributed to the engineers of Dionysius the elder, ruler of the Greek colony of Syracuse in Sicily, who in 399 BC, prepared his city for a long war with Carthage. He also simultaneously started a vigorous research programme to update his weapons which included the catapults. His engineers for the first time mechanised the drawing and releasing of the arrow.

The basic piece in the catapult was the stock, a compound beam that formed the main axis of the weapon. Along the top of the stock was a dovetail groove, in which another beam, the slider, could move back and forth. The slider carried on its top rear surface a claw-and-trigger arrangement for grasping and releasing the bowstring. The arrow was launched from the trough placed on the top of the slider.

The catapult was placed on the pedestal when researchers came with larger designs. To facilitate aiming, a special joint called the universal joint was devised to connect the stock with the pedestal. The replacement of the flexible bow by the torsion spring gave further boost to catapult engineering (see figure on page 62). Tightly stretched bundles of elastic fibres, consisting of animal sinew, horsehair or human hair, were further strained by a rigid bow limb as the catapult was brought to a full draw. A pouch woven into the centre of the bowstring held the missile, and a ring attached behind the pouch was grasped by the trigger claw. The washers at the ends of the torsion bundles could be rotated and



Latest of slings, all designed and manufactured in the US. Compact and sturdy, the ComBow Sling **(above left)** ***has double tubing over rollers. Maxima Folder (above right) with an extended fork carries extra power***



ILLUSTRATIONS BY DHANANJAY

Sling Pistol (above left) shoots ball bearings. Pocket Rocket (above right) is a sport slingshot

then pinned in place to adjust the tension before firing.

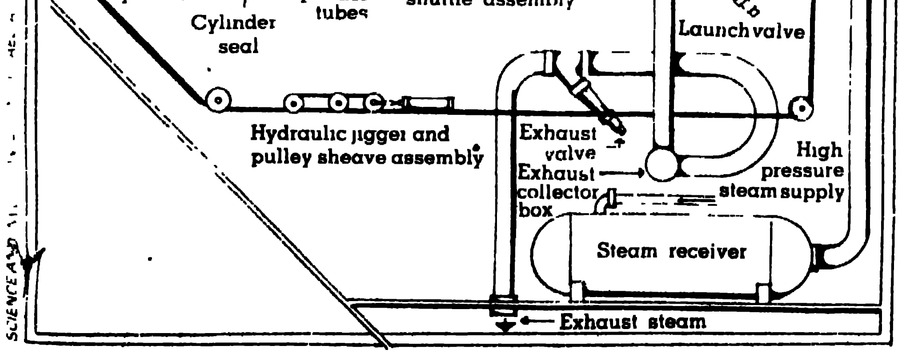
When the torsion principle was perfected it became possible to fire a stone weighing as much as 78 kg. The Roman military engineer Vitruvius gives dimensions for catapults firing stones as heavy as 162 kg although such giant machine may never have been actually constructed. More typical machines fired balls weighing from 13 to 26 kg. The longest recorded range for a catapult firing an arrow of the ordinary size, that is of about 70 cm, was about 640 m.

Researchers under Philip of Macedon, the father of Alexander the Great, perfected the torsion spring. The campaigns of Alexander also gave rise to very powerful catapults. There is reason to associate the rise and fall of large empires with the advent of the catapult.

Even today, the rise and fall of large nations depends to an extent on catapults. You may wonder how. Modern mechanisms using hydraulic pressure, tension or other force to launch gliders, aircraft, or missiles are also called catapults. The warplanes on the aircraft carriers take-off by the help of catapults

Initially, the aircraft were light and slow and could easily take off from the relatively small deck space available on the aircraft carrier. But when heavy and sophisticated models were introduced the available space wasn't enough for them. So catapults were introduced at the forward end of the ship to accelerate the aircraft upto flying speed.

The layout of a modern steam catapult on an aircraft. The piston moves from right to left. At the front is a retardation probe to slow it down



For nearly 30 years hydro-pneumatic catapults were used to launch the aircraft. The advent of heavier and sophisticated aircraft made them obsolete. The air pumping system was complex and enormous in size and could not perform satisfactorily to meet the increasing demands of air battle. At this juncture Commander C C Mitchell of the Royal Navy, UK, came out with the slotted cylinder technique which is currently in use on aircraft carriers.

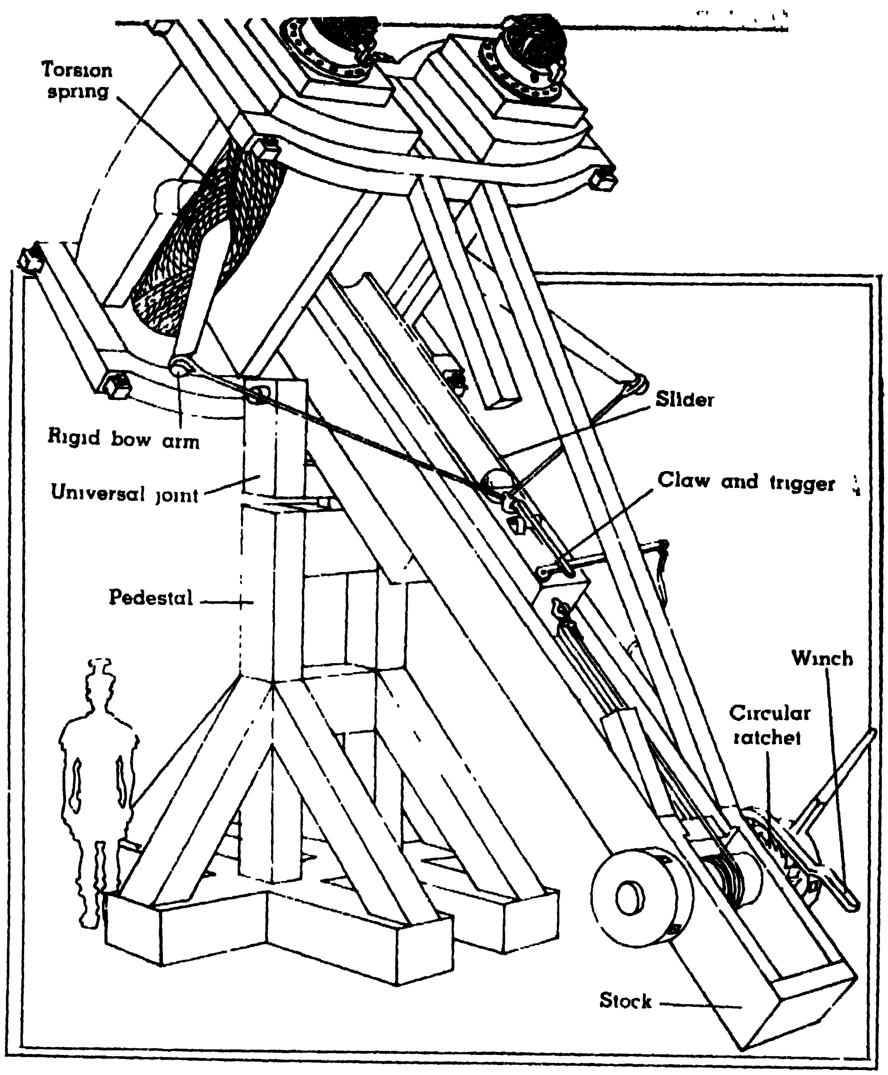
In this technique the piston is directly connected to the aircraft by means of a lever protruding through the side of the cylinder *(see figure). HMS Perseus* of the UK, became the first ship to be fitted with the experimental steam catapult in 1949. After four years of experimentation the Royal Navy found the new catapult acceptable. The US Navy also followed suit a little later.

If this is the broad-based use of its principle, the sling in its simple form has been a constant companion of hobbyists, hunters and competition shooters Writing in *Popular Mechanics* (January, 1984), Angus Laidlaw baptises the art of shooting slingshots as "catapultry" He says, catapultry 'has burgeoned quietly in the shadow of the compound bow, the crossbow and black powder shooting sports "

A small hand catapult is called a sling or a slingshot. It is made by fastening an elastic band on each prong of a forked stick and the elastics are connected by a leather pouch. The pouch can hold anything from a pebble or a marble, to small metal bullets—lead or steel The fork is held in one hand and the elastic is stretched with the other The shot is hurled when the elastic is released.

The shooting spree enjoyed by children with the sling, however, has also brought a bad name to it. The sling can cause serious injury to human beings, birds and animals. Most of the cities in the US forbid the use of

Roman stone-throwing catapult. Torsion springs, whose tension could be adjusted before firing, enabled engineers to build larger models. These were capable of launching stones weighing 78 kg



SCIENTIFIC AMERICAN

slings However serious catapult shooters have been holding national and international matches as well as local competitions. Big game hunters also find effective uses for slingshots as auxiliary equipment.

To match the shooting ability of catapult enthusiasts engineers in the US in recent years have come out with new sophisticated designs that use flat latex driving bands, surgical tubing moulded and tapered bands. Catapults are available mounted on steel or aluminium frames. Handgrips of wood or plastic are also provided *(see figures on page 61)* to increase accuracy while shooting

In our country the sling is yet to take deep root Tribals use it in its simplest form as an effective armour for hunting small game. School children enjoy shooting birds and fruits with it Serious lovers of catapultry are a rare species to find.

Sylvester Lobo

AWARDS AND APPOINTMENTS

NUCLEAR POWER BOARD CONSTITUTED

DR M R SRINIVASAN, director of Power Projects Engineering Division (PPED) of the Department of Atomic Energy (DAE) has been appointed as the Chairman of the newly constituted Nuclear Power Board under DAE.

The Board is instituted to carry out the envisaged nuclear power programme of generating 10 000 MWe by the year 2000 It is responsible for the design, construction, operation and maintenance of nuclear power stations in the country

Dr. Srinivasan, recipient of various awards including the Padma Shri and the Sanjay Gandhi Award for Science and Technology, joined DAE in 1955 and has been the director of PPED since 1974

He has been associated with the construction of the Apsara atomic research reactor at the Bhabha Atomic Research Centre, Bombay, and the Tarapur Atomic Power Station

Amrut Modi Research Award

DR DILBAGH RAI SHRIDHAR, General Manager (R&D) of the Indian Drugs & Pharmaceuticals Ltd. Research Centre, Hyderabad, has been selected for the 12th Annual Amrut Modi Research Award for the year 1981 for his outstanding contributions in the field of Pharmaceutics Dr Shridhar shares the award with Dr (Mrs) M. R. Baichwal of C U. Shah College of Pharmacy, Bombay The award carries a cash prize of Rs 10,000 and a citation

Jawaharlal Nehru Fellowships

DR. GANESAN VENKATARAMAN, Director, Physics, Instrumentation and Electronic Group at Reactor Research Centre, Kalpakkam, is among the three who have been awarded the Jawaharlal Nehru fellowships for 1984. The other two are Mr. A. K. Bhattacharya of Calcutta and Dr. D. D. Sharma of Chandigarh.

THE NAME GAME

Gillian Valladares

"A LEMON that had a chance and took advantage of it," that's Oscar Wilde's description of a grapefruit. The same fruit goes by another name—*Citrus paradisi*. This botanical appellation also indicates the geneology of the grapefruit and its description. This system of binomial nomenclature now used the world over by scientists, was deviced by Carolus Linnaeus, a Swedish botanist. His book *Systema Naturae*, first published in 1735 used two words to describe each species. The first described its distinguishing characteristics and the second gave its generic name which stood for the group to which it belongs. Linnaeus' classification was later refined. It has helped us catalogue the vast, amorphous diversity of life and to understand the underlying unifying relationships. Given below are ten binomial names. Can you correctly "join" the creatures or plants from the alternatives? Answers on pgs 72, 73.

(1) Hedophyllum sessile:
(A) Sea walnut
(B) Sea cucumber
(C) Sea cabbage
(D) Sea onion

(2) Musca domestica:
(A) Dragon fly
(B) House fly
(C) Butter fly
(D) Fruit fly

(3) Naja (Ophiophagus) hannah:
(A) Krait
(B) Python
(C) King snake
(D) King cobra

(4) Leo tigris:
(A) Panther
(B) Leopard
(C) Lion
(D) Tiger

(5) Homo habilis:
(A) Modern man
(B) True man
(C) Neanderthal man
(D) Tool making man

(6) Erythroxylon coca:
(A) Cocoa
(B) Coconut
(C) Cocaine
(D) Cola

(7) Citrus paradisi:
(A) Citronella
(B) Grape fruit
(C) Lemon
(D) Orange

(8) Nelumbo nucifera:
(A) Lotus
(B) Water hyacinth
(C) Water cress
(D) Water lemon

(9) Solanum jasminoides:
(A) Potato bean
(B) Potato vine
(C) Potato
(D) Sweet potato

(10) Prunus armeniaca:
(A) Prune
(B) Peach
(C) Apricot
(D) Cherry

BRAIN TEASER

WHO IS ENGAGED TO WHOM?

THREE young men Rakesh, Kamal and Tarun are engaged to three girls Monica, Rajni and Kalyani. One of the would-be grooms is a doctor, the other is an engineer and the third is an IAS officer. Among the girls one is a teacher, the second, a clerk and the third, a writer. Please note that the names and the professions are not given in any serial order.

From the data given below can you find out the profession of each person and who is engaged to whom?

1. 'Kalyani wanted to marry an engineer. Why did she change her mind?' asked the teacher.

2. 'Oh! She is ill all the time. She wants a doctor at home,' said Monica jokingly.

3. On hearing her two friends Kalyani became irritated and snapped, 'Will you please shut your mouth writer? You have taken away my boy friend Tarun.'

4. The first name of the husband and the wife will not begin with the same letter in any case.

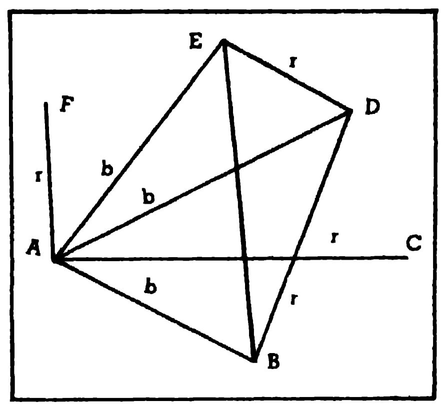
(Solution next month)

Debabrata Chatterjee

Solution to June teaser

Special triplets

Referring to the hints, let ABCDEF be the six points. Consider any one point, say A and the five lines from A, namely AB, AC, AD, AE, AF. However these may be coloured, it is obvious that at least three of them are of one colour. For definiteness, let us say that AB, AD, AE are black and AC, AF may be red or black. Now if the sides of the triangle BDE are all red, then we have proved the proposition. If they are not all red, at least one of them will be black, say BE. Then, ABE will be a triangle all of whose sides will be black. So in any case, whatever may be the scheme of colouring the lines, red or black, there will always be a unicolour triangle and this completes the proof.



There is a stronger result than what we have proved. If six points are joined by all the possible 15 lines coloured black and red arbitrarily, there will always be not one, but two unicolour triangles (both red, both black or one red and one black). But, the proof is not easy. You may congratulate yourself if you find a proof.

Dr Amar Chand Datta from Jullundur and H. B. Kantawala from Baroda have sent in correct solutions to teasers 'How many posters?' and 'Who keeps lovebirds?' respectively.

THE MARTIAN CHITAR

Narayan Dharap

This is the concluding section of the two-part condensation of the award-winning sci-fi novelette by Narayan Dharap. Vijay is a dreamy, intelligent child of thirteen who lives with his parents in a small town. One day he has a close encounter of the third kind with a iridescent spacecraft from Mars.

"VIJU," Nana said, "wait in my room, will you? I'll join you in a moment."

Nana was back in less than five minutes. He sat behind his table staring at the three small, shining cubes which he'd taken out of his pocket. Vijay was waiting breathlessly for Nana to speak.

"Viju, where did you find these, ah, things?"

"I told you Nana! On the grounds."

"Yes, I remember. I went there. Vijay, I could find nothing there... no marks... nothing..."

Vijay kept quiet. Nana was talking to himself:

"And I don't believe in miracles. Then what is this? Where did these cubes come from? In what super-laboratory were they fashioned? What wondrous machines made them?"

"Nana, what are they?" Whispered Vijay.

"Oh, that? Even a sophomore could tell you... The glass-like thing is plastic, the silvery-white cube is platinum and the third is gold. But that's only the beginning! All my experiments have failed to work on these cubes. Their physical properties are simply miraculous! Viju, you are too young to understand all that I say and I'd be afraid to repeat it to any scientist. But I'll tell you only one thing: these cubes are unique!"

"Nana, where can one get such things?"

"Only a boy like you would ask such a question! No!"

"But Nana, gold, platinum, plastic, they can be bought, can't they?"

"Yes, Viju, but *ordinary* gold, *ordinary* platinum...not *these!*"

"Well, what's the difference?" Vijay was exasperated.

"*Everything* is different! The plastic...it remains unaffected by heat and cold. It's totally opaque to ultraviolet rays, x-rays, gamma rays...there's no cosmic-ray trap in our laboratory, but I wouldn't be surprised if *they*, too, are stopped. And yet, it is harder than a diamond and very light! What more do you want! The electrical resistance of the platinum cube is almost negligible. . and the golden cube ..oh! what's the use?"

"GOGRAM?" Vijay called out softly.

YES, VIJAY! The response was prompt

"Why are you silent today?"

VIJAY, YOU ARE ANGRY WITH US, AREN'T YOU? BECAUSE WE SENT AN ORDINARY MACHINE TO YOU

How could he deny it? And then he felt his petulence, felt ashamed of himself. After they had explained everything to him, it seemed childish.

"Yes, I was angry; also sad and disappointed. Nothing seems to go right. I can't help you, I can't meet you, and today Nana said those cubes of yours can't be had anywhere."

Gogram laughed. A ringing, infectious laughter. Nothing seemed to worry him, no obstacles bothered him. Vijay's sombre face also broke into an unwilling halfsmile.

THAT'S THE SPIRIT, VIJAY! I SAW YOUR GRAVE FACE AND THOUGHT YOU HAD TO SMILE FIRST

"But Gogram? What about your mission?"

WHAT ABOUT IT, INDEED! SUPPOSE WE PULL LONG FACES, IS IT GOING TO HELP? IF ONE WAY IS CLOSED, WE'VE GOT TO FIND ANOTHER, ISN'T IT? THERE *MUST* BE ANOTHER, VIJAY!

"Does nothing ever worry you?"

VIJAY, REMEMBER THAT WE ARE THE CHOSEN ONES THEY'VE SENT US ON A LONG AND A PERILOUS JOURNEY! NOBODY KNEW WHOM OR WHAT WE'D MEET, WHAT DANGERS ONE MIGHT ENCOUNTER SO THEY CHOSE THE BEST, THE BRIGHTEST AND THE BRAVEST OF OUR RACE

"Well, I'm ready to give up. Tell me what *you* are going to do!"

ALL RIGHT WHAT DID YOUR PROFESSOR SAY?

"He told me the name of the materials—plastic, platinum, gold. And that's all he could say."

FINE AND NOW WHERE ARE THESE THINGS AVAILABLE?

"I think we have plastic factories—but yours is different."

ALL RIGHT WHAT ABOUT THE OTHERS?

"Gold is pretty valuable. I think they keep it in banks."

WELL, FINE! LET'S GO THERE THEN!

"But Gogram!" Vijay was aghast "These banks are not *shops?* They don't sell it there!"

THEN WHY DO THEY KEEP IT THERE?

"Ah——I think notes and coins have got something to do with it" Vijay was confused.

VIJAY, CALM DOWN YOU ARE FLUSTERED LET ME SEE WHAT YOU KNOW ABOUT IT JUST KEEP STILL.

Vijay had a very strange sensation..as if a very light feather was moving over him, the touch as faint and light as the faintest breeze. but it was a breeze from other worlds, from unimagined voids... his small body shivered at the alien touch . .

ALL RIGHT NOW I KNOW. YOU DON'T USE GOLD DIRECTLY, BUT USE IT INDIRECTLY IN YOUR DEALINGS YOU SEEM TO VALUE IT HIGHLY PLATINUM SEEMS TO BE EVEN MORE SCARCE, IN THIS TOWN AT LEAST SO GOLD IT HAS TO BE IF WE TAKE IT FROM THIS BANK OF YOURS, WE WILL BE COMMITTING A CRIME IN YOUR LAWS SO WE MUST FIND A WAY AROUND THIS

Gogram was silent. He might have been thinking, but Vijay did not know *where* he was. The human shape before him was just a machine, a robot. Gogram was using it as and when he wanted it. Now, at this moment, when the *sense* of Gogram was withdrawn, was it totally lifeless?

VIJAY! I HAVE AN IDEA! YOU USE GOLD TO BUY OTHER THINGS CAN'T WE TURN IT THE OTHER WAY-ROUND! SUPPOSE WE TAKE THE GOLD AND REPLACE IT WITH OTHER THINGS OF THE SAME VALUE!

Somehow, this didn't seem right to Vijay. "But Gogram! Suppose they *don't* want to sell?"

HA! HA! AND WHO'S GOING TO ASK THEM! WE REPLACE GOLD WITH ARTICLES OF THE SAME VALUE THAT'S ALL! THEN WE WON'T BE COMMITTING ANY CRIME, WOULD WE? SUPPOSE THEY DON'T WANT THESE THINGS THEN THEY CAN SELL'M OFF AND HAVE THEIR GOLD BACK DON'T YOU AGREE!

Vijay certainly did *not* agree with this. He had a suspicion that the bank, *any* bank, would not be very eager to use its gold for such complicated deals, but he kept silent.

VIJAY, NOW HERE'S A JOB FOR YOU! I WANT A PIECE OF GOLD SOMEWHAT THE SIZE OF YOUR HEAD FIND OUT WHAT'D BE ITS PRICE AND ALSO FIND OUT WHAT ARE THE THINGS WHICH WE CAN MOST CONVENIENTLY PUT IN THE PLACE OF GOLD WE ARE GOING TO REMOVE

"Now?"

CERTAINLY NOT NOW! TOMORROW EVENING WOULD DO NICELY! I'LL ALSO HAVE TO MAKE CERTAIN PREPARATIONS CERTAIN EXPERIMENTS WILL HAVE TO BE CARRIED ON ON THE GOLD BY THE WAY VIJAY CAN YOU FIND A SHELTERED, UNOCCUPIED PLACE, WHERE WE CAN CARRY OUT THE WORK?

"How big a place?"

SAY THE SIZE OF YOUR ROOM

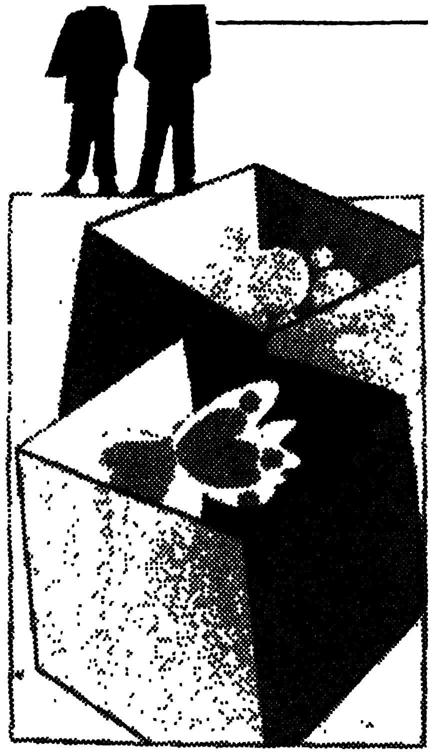
"But your experiment Will there be any breakage?"

NO NO VIJAY! BUT WE MUST HAVE POWER

"Gogram, by the side of our house is the Patwardhan bungalow They have a garage at the back It is empty, so see if you can use it . but but Gogram, Minnie Patwardhan is a friend of mine so if there is going to be any explosion, any fire or heat. ."

I UNDERSTAND, I UNDERSTAND PERFECTLY VIJAY! Vijay didn't know why Gogram was laughing; NO HARM WILL COME TO IT, VIJAY!

VIJAY'S first waking thought was the work entrusted to him. A block of gold, the size of his head, Gogram had said. Now how to work out the price of this gold? He would



have to go to Father

"Father!"

"Yes, Vijay?"

"I want to ask you something."

"Yes?" Father sighed and put the newspaper away.

"Father, what'd be the price of a gold ball, say the size of my head?"

"What?!" Father stared at Vijay in surprise.

"I want to know, Father! Please!"

"Is it something the teacher has asked you?"

"No no-I just want to know for myself."

"Well, you want to know the strangest things, don't you?" But he smiled and said, "Get your mother's tape and paper and pencil."

Vijay followed Father in his room. Father was searching through some faded-looking books. "My mathematics has also grown rusty now. Ah! Here it is ..yes, come on." He took the tape from Vijay's hand. "Let's measure the circumference of your head . how much? Fifty point one centimetres? O K. Write that down. Actually your head isn't a perfect circle with all these bumps in the front and this flatness at the back, but let's use a favourite phrase of the mathematicians and assume that it is a perfect circle– or sphere to be exact . so the circumference is 50.1 centimetres, divide it by 3.14, that's 'pie' you know, that gives us the diameter."

He checked Vijay's calculations and said, "All right. Let's take sixteen, a round number. That gives us eight as the radius. How would you find the volume of a sphere with an eight cm. radius?"

"Would that be four-thirds pie-radius-cubed?"

"Yes. Work it out. how much? Oh! Say 2150 c.c. - won't make much of a difference. so this is the volume of the gold sphere you want, how do you find its weight?" After looking at Vijay who kept discreetly silent, he went on. "Why! Multiply it with the density of gold! So that will give you its weight in grams! And then find out the price. The present official price is one sixty-five rupees for ten grams * totally unpractical of course! But so is your problem! You will find the density of gold in the end tables of your physics book. Is that all?"

"Yes, Father," said Vijay and ran out of the room.

His father stared at the vanishing figure for a long time.

Vijay finished the complicated sums in his room. The figure that finally emerged was awe-inspiring. What on earth (!) was Gogram going to give in exchange for such a colossal figure? and how?

The figure before him was rupees two lakh sixty-six thousand and four hundred!

Whatever else it was, interplanetary travel was certainly not cheap.

He hated to bother Father again, but his brain just wouldn't work.

He broached the subject at mealtime.

"Father, the cost of gold is over two lakh rupees."

"What gold?"

"Oh, don't you remember, this morning I told you."

"Yes, yes," Father said hastily, "So you got your answer."

"Father," Vijay persisted, "Suppose somebody wants to dispose off this gold– and wants to purchase something else--- what'd he choose?"

"Say, what's all this about gold and sales?"

"Please, Father! I've got to know."

"Well, he'd be a lucky man. He could buy anything– a car, a house."

"No, no, nothing so huge. Say, something small."

"Why'd he bother to sell the gold then? It is 'small' enough."

"Father, please don't make fun of me. Tell me."

"O K. Valuable but small eh? Diamonds? Rubies?"

"They are to be bought, isn't it? No!"

"Valuable pictures? Masterpieces? Rare first editions?"

"No! Nothing from the shops!"

"What else, then? Pearls from the sea?"

"Pearls, yes! That seems better! Anything else?"

"Trying to quiz me, are you?"

"Oh, no, Father! I am very serious."

"Righto! Let me think. you want something small, valuable, not to be purchased, not belonging to anybody...correct?"

"Yes, correct, Father."

"Pearls, I already told you. There are other things..valuable stones, they are found near extinct volcanoes and nobody owns them not until they are found, that is, and then there are butterflies; rare ones. I've heard cases where real rarities have fetched thousands of dollars . is this enough?"

"Where are these butterflies found?"

"Any inaccessible place, of course! The Amazon basin, or ."

"That's enough, Father, and thank you very much."

Father stared at him for some time and then said, "Now young man, will you tell me why you want all this information?"

"Father, it's for a story I am writing. its a *secret* story."

For the moment at least, Father seemed to be satisfied.

THE man whom Vijay called Gogram was standing on the mount. As Vijay reached him, he felt a shift, a change, an *awareness*.

"Gogram!"

YES VIJAY I'M HERE I SEE THAT YOU HAVE DONE THE JOB

"Yes. First about the gold. The price comes to about two and three quarter lakh of rupees. Do you know what *that* means?"

YES I KNOW VIJAY GO ON

"In its place, we can keep these things three things they ." Vijay tried to explain what Father had told him, but failed. He couldn't find the proper words. And once again Gogram said,

STEADY, VIJAY LET *ME* SEE WHAT YOU MEAN

And with these words came the strange sensation, a light feather searching and searching through all the nooks and crannies of his brain.

VIJAY! THAT'S WONDERFUL! WE'LL HAVE ALL THESE VALUABLE THINGS HERE BY TOMORROW!

"By tomorrow?" Vijay couldn't hide his surprise.

WHY NOT? OUR CHITAR IS HURTLING ROUND YOUR EARTH WE NOW KNOW WHERE TO LOOK FOR THESE THINGS WE HAVE MACHINES WHICH WILL TRACE AND FIND OUT THEM SO YOU SEE THERE'LL BE NO DIFFICULTY NOW WHAT ABOUT THE PLACE? IS IT AVAILABLE?

"Yes, there is such a place; big, empty, with power lines."

WHY, VIJAY! EVERYTHING IS PERFECT!

"Oh, Gogram."

VIJAY, I SEE YOU HAVE A LOT OF QUESTIONS BUT WILL YOU EXCUSE ME NOW! WE HAVE TO SET THE

His face suddenly lost its colour. He had never thought of the newspapers! Now everything was out!

MACHINES SEARCHING AND WE HAVE TO PREPARE ONCE THIS JOB IS FINISHED I WILL ANSWER ALL YOUR QUESTIONS SHALL I GO NOW?

"Oh, all right... yes, you can go.. "

AND VIJAY, WHEN YOU COME TOMORROW BRING A PAPER AND PENCIL WITH YOU

"Paper and pencil?"

YES! WE'LL KEEP A LETTER FOR THE BANK EXPLAINING EVERYTHING SO GOODBYE UNTIL THEN, VIJAY!

THERE were *two* tall men standing on the mount.

Gogram and Gogran! So they both had come today! In spite of knowing all this, Vijay couldn't keep the dread out of his mind.

VIJAY, THIS IS MY FRIEND AND PARTNER GOGRAN!

VIJAY! The voice was subtly different but equally grave, vibrant and friendly

I AM GOGRAN WE BOTH ARE VERY VERY GRATEFUL FOR YOUR HELP

"Gogram, did you find these things?" Vijay asked

WHY, YES! IT WAS THE EASIEST THING OF ALL! LOOK!

The two were so exactly alike that he just couldn't tell them apart. (And they *had* to be alike, he thought; after all, they were but machines; manufactured by the hundreds!) One of them put his hand in the overcoat pocket and brought out two small boxes. He held them before Vijay They seemed to be made out of some milky white, plastic-like substance, their tops were transparent

Vijay bent down to look in the boxes. One held six butterflies; gem-like wings, exotically coloured, all in perfect condition And below each was a dirty greenish-yellow coccoon; that too in a perfect state.

VIJAY, said Gogram WE DON'T KNOW MUCH ABOUT YOUR INSECTS. WE TOOK A PROFESSOR'S HELP- A MAN SUDDENLY ROUSED FROM SLEEP AND ASKED ON THE TELEPHONE INFORMATION ABOUT INSECTS THEIR RARE SPECIES THEIR SPECIAL FEATURES, THEIR HABITAT, THEIR MARKET VALUE THE PROFESSOR MUST HAVE TAKEN ME FOR A MADMAN BUT HE GAVE US THE INFORMATION

"Where did you find these?" asked Vijay

YOU CALL IT THE AMAZON BASIN

Vijay looked into the other box The slanting rays of the setting sun were falling in... the box gave out the colours a thousand times enriched...in blazing reds and iridescent greens ..emeralds and rubies! Along with them were a number of big pearls...

THE WHITE BEADS, PEARLS, AS YOU CALL THEM. THOSE WE FOUND NEAR THE COAST OF SRI LANKA AND THOSE COLOURED STONES *THEY* TOOK SOME FINDING SOME OF THEM COME FROM CENTRAL ASIA, SOME FROM PACIFIC ISLANDS

"And all this in one day!" Vijay was incredulous.

EASY WHEN YOU HAVE MACHINES TO DO YOUR EVERY BIDDING, VIJAY! DO YOU THINK THIS IS SUFFICIENT?

"I-I-think this is far more precious than the gold "

THE MORE THE BETTER! WHAT ABOUT THE PENCIL AND PAPER? GOOD SIT DOWN AND WRITE AS I TELL YOU

Vijay sat down on a rock and held the paper pad on his knee The letter he wrote has since become world-famous and probably everybody has read it:

The Manager,
Great Universal Bank, Ltd ,

This may come as a shock to you but not too unpleasant, we hope We were in dire need of about 40,990 grammes of pure gold You have substantial stocks of gold in your vault.., but we somehow feel that we would not be able to convince you of our need It is therefore a sad (and accomplished) fact that we are removing this quantity of gold from your vaults without your permission But we are at the same time taking every care that the Bank suffers no financial loss due to our action In the place of gold, we are substituting certain articles whose value exceeds the value of the gold we have removed It is our sincere hope that you will bear the small inconvenience thus caused, bearing in mind that it is in a noble cause We request you to accept the articles thus kept by us This is a very extraordinary transaction, but it is our hope that you come to no loss

We are grateful for your (unintentional) help

Yours sincerely,
A B C & D

Gogram (or Gogran) reached forward, took the letter and the boxes and immediately marched off

"He is going there now?" Vijay asked.

YES WHY WAIT?

THE morning dailies had the "bank robbery" in screaming headlines

GREAT UNIVERSAL BANK ROBBED!!! STRANGE LETTER! GOLD REPLACED BY GEMS AND BUTTERFLIES!

The late news said.

'The Mystery of the Bank Robbery has deepened by the many new facts brought out in police investigations.

"According to experts, the letter was written by a small boy. But otherwise, there are no traces or prints. This shows that the paper was meticulously cleaned, leaving no prints.

"The butterflies are very rare and are in an excellent state, which means that they have been recently trapped The only difficulty is that they are found only in *South America!*

"On examining the jewels and gems and pearls, experts say that their aggregate value is much more, even twice as much as that of the gold lost by the Bank!

"The riddle as to how they entered the best protected vault has also been solved It seems that a tunnel was dug from the river bed to right under the vault to which they gained entrance through a hole blasted in the floor If they have gone to all this trouble, then the theft of gold seems merely a blind Their real target may have been some other valuables or documents stored there

"Diligent search is on and an arrest or arrests are expected in the near future."

"Vijay!" Father roared and Vijay scrambled out of his bed and ran to his Father. "Have you seen this?" Father waved the paper in Vijay's face, obviously he couldn't have because he had just got out of bed. But the big headlines hit him like a straight punch in the face His face suddenly lost its colour He had never thought of the newspapers! Now everything was out!

"Vijay, this seems a curious coincidence, doesn't it?"

Vijay didn't say a word

"So all that hogwash about story writing and so on was a lie?"

'Yes, Father' He whispered

"Oh, this is the limit!"

'Father I would have told you everything to start with, but you wouldn't have believed a word of it! I met those strange people that evening I'm meeting them every day.'

"Oh! So your Martians are at the back of this, are they!"

'Oh Father! They are no robbers! They just want to repair their machine! Oh, they

Broad bands of deep violet bathed the central golden core. It seemed to shimmer and change perceptibly

are so simple, so straight, so innocent! They could have taken this gold from any place! They can go through rock and water and steel . No lock can stop them But they just *won't* do it! Oh, they are no thieves! They have their own rules!"

"And they did all this in one day?"

"Yes Father!"

"Vijay, I'm beginning to fear that some clever gangsters have used you as a tool."

"Oh Father! Come with me! Meet them!"

"Me?" Father evidently hadn't expected this

"Yes! Will you come? Today evening?"

"Well, I will certainly give you a chance before declaring you as a cheat and liar.. Yes, I'll come!"

"Oh, Father. ." Vijay broke down, Father stared at him in sudden perplexity; he felt a sudden affection and pity for this small, suffering soul...

VIJAY reached home but he was feeling uneasy. He was standing by the gate when father returned about twenty minutes later. Father stopped by him and seemed to be on the point of saying something; but finally seemed to decide against it, simply nodded at him and went in His face was slightly perplexed and also slightly worried. But the moment Vijay feared most never came neither on that day nor on any subsequent occasion did father talk about those 'Martians' Standing alone near the mount, in the presence of Gogram (invisible to him) he had gone through some soul-shaking experience; but he never talked about it He kept all that to himself

VIJAY was tossing impatiently on his bed Gogram and Gogran are going to finish their experiment tonight and fly off. What a life! What tremendous excitement! What adventure! A journey to the far, far space . beyond the limits of the Solar System! Mars and Jupiter and Saturn and Uranus and Neptune and Pluto mere halts on the way! Oh! How his small soul yearned for such a life! They'll go on and on maybe even reach a star! and Man was clamouring for a beggarly step on the Moon!

Sleep? That was the thing farthest from his thoughts now!

VIJAY! Gogram was calling VIJAY! WE RE READY! COME ON!

Vijay jumped out of the bed and very very quietly opened the window The cold night wind came in an icy blast sending a shiver through him. But tall Gogram, blacker than the night, was there and calling him. Vijay stepped out; Gogram started to walk and Vijay followed him. In a moment though he whispered:

"Gogram, shall I keep the window open?"

WINDOW? OH! NO, VIJAY, DON'T WORRY ABOUT IT - COME!

They stealthily reached the unlit garage Gogram opened the door and they stepped in; the door closed behind Vijay and suddenly there was light inside. Vijay saw that Gogram (or Gogran) was standing inside, all ready to proceed.

The room was empty, except for a complicated shape right in the middle of the flagstone floor. The convoluted shape had a transparent centre where nestled the glowing yellow block of gold! Two thick wires snaked out of the plastic skeleton and reached the wall plug.

READY? Asked Gogram, standing near the central shape.

READY Gogran said GO ON! WATCH, VIJAY!

With the click a deep humming sound began, a strange glow came on, dim at first but slowly brightening and changing into broad bands of deep violet that bathed the central golden core. It seemed to shimmer and change perceptibly, it lost its yellow dullness and now was a shining, glittering white—Platinum!

VIJAY, TOMORROW THERE'S GOING TO BE A HUE AND CRY WE HAVE USED COLOSSAL AMOUNT OF POWER POSSIBLY YOUR GENERATORS MAY GO OUT OF ACTION NOT FOR LONG, WE HOPE

IT was midnight. Cold and awfully silent Gogram walked in front, the cubes cradled in his hands; Vijay and Gogran followed Vijay was not surprised when they turned towards the ground In the pitch dark they reached the central mount

VIJAY! LOOK UP! THERE!

Vijay looked up, just in time to see a yellow-red spark separate from the immensity of the heavenly stars These two were moving, plunging down through the dark night .. and in a few moments, the multihued, shining "something" came down, floating like the flimsiest of soap bubbles The corners and the edges gave out blinding lights in red, yellow, green and gold ..

COME! said Gogram and took a step towards the lights.

"W-W-What is it?" Vijay asked, a little afraid now

VIJAY! I AM HERE! DON'T BE AFRAID! LOOK!

It was a very comforting voice; strong, soothing, friendly

Vijay slowly opened his eyes again.

What a tremendous sight! He had *never* seen so many stars! And in colour too! The dense atmosphere of the earth had always hid their glory from human eyes... now the earth and its air were left far behind... and the stars shone out in their pure, pristine glory!

VIJAY! YOUR EARTH! LOOK DOWN!

Vijay turned his eyes down. There was the earth! As big as ten full moons... it hung against the immense backdrop of the black heavens; huge and haunting; majestically turning about itself... He could recognise the continents...the sun-line lay across the western part of Europe, the glittering Atlantic ocean... the greenish-gray mountains, the glittering icecaps... Vijay couldn't bear the immense sight...

He closed his eyes...

HERE COMES OUR CHITAR! LOOK!

Vijay looked. From far away, a golden spark was approaching. The speed was tremendous The spark came near, blossomed out into a huge golden flower.. and before he could see the whole of it, they were swallowed up by a yawning black hole..

WE ARE THERE! VIJAY! COME!

Vijay never knew when the transparent walls of their "boat" dissolved away...maybe they never were *really* there. In front of them, was a gigantic door, now opening slowly. The whole place was bathed in a dim, pleasant, golden light..

Following Gogram, Vijay passed through huge compartments and finally reached the biggest of all It had a huge circular wall and a curved window occupied almost half of it Below the "window" was a semicircular desk, with thousands and thousands of dials and lights on it. The indicators flicked restlessly, lights came on, changed colours, then went off... the machine hummed to itself a strange song of power .. Vijay stood at the door, transfixed.

Gogram went straight to the panel. One particular light was coming on, turning an angry red and going on... off. Vijay, who know next to nothing of machines, even he could see that the machine was giving some insistent information, off; on... off...

Gogram opened a panel, inserted the shining white platinum cube inside; there was a satisfying "click"; the light above turned green and stayed on; somewhere a bell chimed .

OUR WORK IS DONE, VIJAY, Gogram said.

"You are ready to leave?"

YES

"But you were going to show me everything!"

YES, VIJAY COME WITH ME.

VIJAY, WE HAVE VISITED ALL THE PLANETS OF

Your armada of spaceships will rise in the sky—on the forefront will be the bravest, the most valiant—the flower of humanity!

OUR SOLAR SYSTEM FOR YOU ALSO THE TIME WILL COME .. BUT IT'S FAR IN THE FUTURE YET. SEE WHAT WE HAVE SEEN

Living three-dimensional projections flashed on the screen. The blazing pools of molten metal on sun-side Mercury; the curious metal formations on the zero meridian; the thick cloud layers of Venus and the mysterious moving lights below it, the surging seas and teeming cities of his earth; Jupiter with its immense clouds incessantly torn by violent storms; Saturn with its ice of frozen methane and the breathtakingly beautiful girdle of rings, the frozen and dead worlds of Uranus, Neptune, Pluto...

"But there's nothing of Mars!" Vijay exclaimed in dismay.

OH VIJAY! THAT'S OUR HOME WORLD! WE WERE ON A TOUR OF EXPLORATION-WE HAD NO IDEA WE'D BE COMING DOWN ON EARTH!

"But how is it? Mars, your world?"

MARS IS BEAUTIFUL, RED, PLEASANTLY COLD.

"We're not sure whether it has anything living on it or not. "

FINE! FINE! THEY'LL KNOW SOON SAY TWENTY YEARS HENCE

"Bue how does it look? How are *they*?"

PRESENTLY, PRESENTLY, VIJAY! YOU WILL SEE EVERYTHING!

Gogram left the room, Vijay following. They passed many chambers on their way, some looked like godowns—packed from floor to ceiling with boxes of that mysterious-looking white substance. Some rooms had what unmistakably looked like guns and weapons. Gogram sensed Vijay's thoughts and said,

VIJAY THERE ARE SOME PLANETS WHICH ARE DANGEROUS HOSTILE WE HAVE TO CAMP THERE AND HAVE TO PROTECT OURSELVES

Vijay remembered the unstoppable march of Gogran through water and rock and steel, and wondered which race had the temerity to oppose and attack so powerful a race; but he had no time for thought Gogram had stopped near a scooter-like three-wheeled vehicle. Gogram climbed up on it and motioned Vijay to follow him

As Vijay stepped on the platform the vehicle started to move It took them through chamber after chamber, level after level. Here was the immense creation of a mighty civilisation—the Chitar of Gogram They had poured all their knowledge and skill in its construction It was a mighty thing, designed to travel trillions and trillions of miles; it would leave the Solar System far behind and enter another system and visit strange planets; it may even leave this home galaxy... There were no bounds; it would reach the limits of vision and then plunge on in the unknown Nobody knew what waited out there for this visitor from a small planet.. The builders had prepared for all eventualities; Vijay was a thirteen-year old earth child; he couldn't even guess the thought patterns of these aliens. . but they were keeping their word.. they were showing him everything....

As Gogram proceeded, Vijay had the sense of going up; also each level was now getting smaller, it was now evident that the Chitar was shaped like an inverted saucer, and now they were approaching the higher and narrower parts of it. As the speed of the vehicle slowed down, Gogram said,

VIJAY WE HAVE SHOWED YOU EVERYTHING THERE'S ONLY ONE THING LEFT

"What?"

YOUR MEETING WITH GOGRAM AND GOGRAN! I AM GOGRAM SPEAKING THROUGH THE ROBOT NEAR YOU VIJAY NOW YOU ARE COMING TO THE ROOM WHICH CONTROLS THE WHOLE CHITAR—AND WE ARE THERE

Vijay said nothing He had said nothing for a long while now. The Chitar sliding past his eyes in its majestic glory had shaken and stirred the very foundations of his being There was wonder and magic everywhere; the mighty machine was set on a course of unimaginable adventures and romance Gogram and Gogran! Nothing daunted them, they faced all dangers and calamities with an easy nonchalance, *and they were his friends?*

Vijay felt the wish stirring deep inside him -

Why shouldn't *he* go with them?

Would there be any joy for him in his normal life after he had gone through this exciting adventure? He'd always be aware of these two fantastic travellers— riding their golden Chitar, stepping across the black universe in million-mile strides how his world had shrunk! His school and his whole life Oh! He'd be miserable, miserable! And yet another thought came whispering Would he *ever* have another chance like this!

The vehicle spun and rose; shot on smooth runways with a dizzying speed, and finally stopped in a bare room. Bare, except for a strange looking chair right in the centre

VIJAY SIT IN THAT CHAIR Gogram said

There was a sadness in the voice, a new thing.

"What's this room for?"

HERE GOGRAM AND GOGRAN WILL MEET YOU GO

VIJAY WE SEE THE PROGRESS OF YOUR SPACE PROGRAMME AND WE HAVE NO DOUBT THAT BEFORE THE TURN OF THE CENTURY, YOU WILL REACH MARS, ACTUALLY *THAT* IS THE REASON BEHIND OUR OWN SPACE JOURNEY!

"That?" Vijay didn't understand.

YES! WE ARE LEAVING MARS!

"Leaving Mars? Your own mother planet?"

YES! BECAUSE MAN WILL NOT ALLOW US TO LIVE IN PEACE!

"But you are *so* powerful! You are afraid of us?"

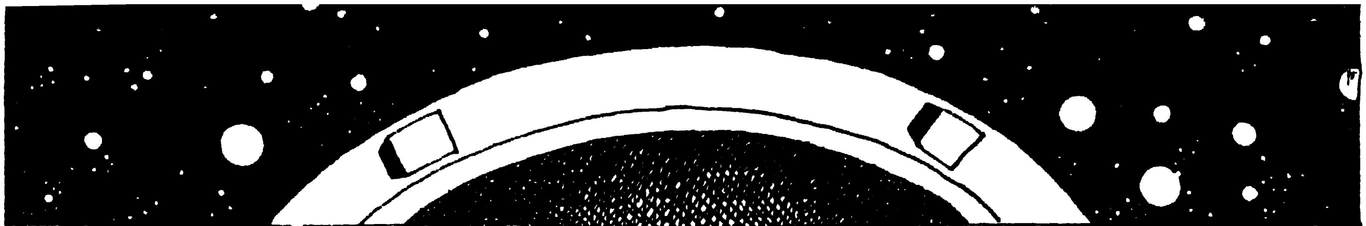
NO VIJAY, WE ARE NOT AFRAID *OF* YOU WE ARE AFRAID *FOR* YOU WE PITY YOU, BECAUSE SEE—WE ARE SUPREME ON MARS, WE HAVE NOT ACHIEVED THIS MASTERY WHO THROUGH VIOLENCE AND BLOODSHED - ALL THE OTHER SPECIES HAVE BEQUEATHED IT ON US VOLUNTARILY WILL MAN EVER ACCEPT SUCH AN INFERIOR STATUS! BECAUSE HE *IS* INFERIOR YOU KNOW —VIJAY, YOU MAY HAVE DOUBTS—BUT I HAVE NONE—BECAUSE I KNOW THE ANSWER - NO! MAN IS INORDINATELY PROUD OF HIS SUPREMACY -HE HAS CERTAIN RARE QUALITIES GRANTED BUT HE CERTAINLY IS *NOT* THE BEST!

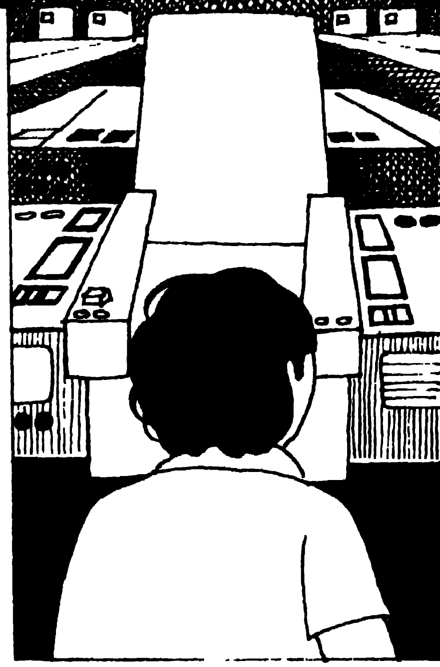
"But you can so easily stop us!"

YES VIJAY-BUT AGAIN—WILL MAN ACCEPT HIS DEFEAT PHILOSOPHICALLY GRACEFULLY! I SAY—NO! ALL THE NATIONS ON EARTH WILL UNITE—TO DESTROY THE MONSTERS ON MARS TO LIBERATE THE OTHER SPECIES FROM SLAVERY! THERE WILL BE PLANS TO MOUNT AN INVASION ON MARS! YOUR PEOPLE WILL TOIL FOR GENERATIONS AND FINALLY YOUR ARMADA OF SPACESHIPS WILL RISE IN THE SKY—ON THE FOREFRONT WILL BE THE BRAVEST THE MOST VALIANT - THE FLOWER OF HUMANITY THEY WILL COME IN THEIR TEEMING THOUSANDS! CAN WE NOT DESTROY THEM? OH SURE! WITH THE SNAP OF OUR LITTLE FINGER! BUT WHAT A MASSACRE! WE JUST WON'T DO IT! AND EVEN IF WE DESTROY THE FIRST INVADERS, IT WILL NOT DETER YOU YOU WILL TRY AGAIN AND AGAIN! THIS DEFEAT WILL BE A BLOT ON HUMAN HISTORY! NO! VIJAY WE HAVE CONSIDERED IT AND HAVE DECIDED ON OUR COURSE WHEN YOU REACH MARS IT WILL BE VACANT NO DANGERS AND NO HELP EITHER! NO ENEMIES AND NO FRIENDS, EITHER

The huge metal wall facing Vijay slid away revealing a huge, slightly curved, glass-like surface Whether it was a real picture seen through the "window" or whether they had projected something on the glass 'screen', Vijay never knew

A picture was slowly taking shape on the glass It seemed to be taken from high up Below spread a wide, bluish belt of sparkling water- -the canal! Graceful crafts floated on it—shining like jewels in yellowish sunlight. There were other shapes swinging through the air. . The canal slid under





ILLUSTRATIONS BY NANA SHIVALKAR

Vijay's eyes and he could now see a beautiful city on its banks. Even from the height, he could sense its artistry, its grace and poise It sat so lightly along the coast of blue water . and then came the strains of *the* music, now familiar to Vijay . He felt choked, suffocated inside.

SUCH IS OUR MARS' Gogram said proudly AND NOW ONLY ONE THING REMAINS, VIJAY! YOU MUST BE EAGER TO SEE US MARTIANS GOGRAM AND GOGRAN!

"Yes.' Vijay could only whisper the word.

YOU WILL GET YOUR WISH BUT THERE'S SOMETHING BEFORE THAT SOON WE ARE GOING TO SEND YOU BACK AND *BEFORE* THAT, WE WILL SEE THAT ALL THESE INCIDENTS ARE WIPED OFF FROM YOUR MEMORY SINCE YOUR FIRST CONTACT WITH OUR LIFEBOAT UPTO THE PRESENT MOMENT YOU'LL FORGET EVERYTHING!

"But why? I won't tell it to anybody!"

THAT'S NOT THE REASON, VIJAY! EVEN IF YOU TELL, NOBODY WILL BELIEVE YOU! NO THAT'S NOT THE REASON!

"Then why?"

AND EVEN IF SOMEONE BELIEVES IN YOU WE DON'T CARE! WE CARE ONLY FOR YOU! WHATEVER OTHERS DO OR DON'T DO, THE INCIDENTS YOU HAVE EXPERIENCED MUST HAVE BURNED THEIR IMPRINTS ON YOUR BRAIN! YOU'LL NEVER FORGET THEM!

"But Gogram! I want to remember them! I want to remember every small detail of this adventure!"

VIJAY, THINK A MOMENT! HAVING SEEN US, HAVING COME INTO SUCH CLOSE CONTACT WITH US HAVING SEEN OUR PROGRESS THE COSMIC PROBLEMS THAT FACE US CAN YOU EVER ENJOY YOUR SIMPLE LIFE ON EARTH? EARTH—WHERE YOUR SCHOLARS HAVE NO IDEA OF OUR EXISTENCE? YOUR TEACHERS HOW CAN YOU HAVE RESPECT FOR THEM? VIJAY YOU HAVE NO IDEA BUT THESE MEMORIES WILL BE LIKE POISON TO YOU! YOUR WHOLE LIFE WILL TURN TO BITTER ASHES FOR YOU! AND WE CANNOT DESTROY YOUR WHOLE LIFE LIKE THIS!

"Oh, but Gogram! Will we never meet again?"

VIJAY I'LL TELL YOU SOMETHING THAT ALSO YOU WILL FORGET SOON BUT LISTEN! WHEN WE DESTROY ALL THESE MEMORIES IN YOUR BRAIN WE WILL MAKE A SMALL VERY SMALL CHANGE IN YOUR BRAIN. IT WILL BE AN ORDER AND IT WILL WORK THROUGH ALL THE YEARS OF YOUR LIFE! IT IS A COMPULSION TO STUDY PHYSICS ASTRONOMY MATHEMATICS GEOLOGY AND CHEMISTRY IT WILL NEVER LEAVE YOU. IT'S AN UNBREAKABLE COMMAND!

"What did study ever achieve for anybody?" Vijay asked tearfully, almost sobbing

OH BUT LISTEN VIJAY Gogram was laughing THIS UNREMITTING DRIVE WILL TAKE YOU TO THE TOP OF THE FIELDS THIS PHYSICAL AND MENTAL SUPERIORITY WILL ENABLE YOU TO BE SELECTED IN THE FIRST BATCH OF BHARATIYA ASTRONAUTS

Vijay had strained forward eagerly but had again slumped back in his chair

"Oh what's the use? It'll take at least twenty years!"

SO WHAT? Gogram was surprised

'What's your life span?'

WHY SAME AS YOURS- SAY NINETY YEARS!

"So this! By the time I am ready, you will be a doddering, senile old man!"

AHA! BUT VIJAY YOU FORGET ONE THING! OUR YEAR IS A MARTIAN YEAR MEANS ABOUT TWENTYTHREE OF YOUR MONTHS

And now Vijay was curious and eager

SO YOU WILL BE ONE OF THE FIRST BHARATIYAS REACHING MARS AND VIJAY! THE MOMENT YOU STEP DOWN ON MARS, THE BLOCK IN YOUR BRAIN WILL VANISH! YOU WILL REMEMBER THIS AND EVERYTHING! AND THEN YOU WILL MEET US! WE GOGRAM AND GOGRAN WILL BE THERE TO WELCOME YOU! THIS IS A SOLEMN PROMISE!

"Twenty years! Still it's something " There was a smile on Vijay's face now

IS EVERYTHING ALL RIGHT? ARE YOU READY?

"Yes, Vijay said with as much courage as he could muster, but his heart had already started to hammer and his pulse had already started to race.

The music now stopped; there was a queer stillness around him..

And then the ponderous metal wall slowly shifted and he saw that the room in which he was sitting was after all a part of a much larger apartment. The far side was in semi darkness.. and in the half-light Vijay could see something... huge and moving...

It was moving nearer, towards him. The disturbing outlines became sharper, clearer and the hammering in his heart quickened

They were huge, they had a phospherescent sheen...

They had warned him so many times. WE ARE DIFFERENT! They had said; and yet, he has not truly understood; he was innocent and unprepared.

They had greenish-yellow shining bodies; their shapes were monstrous, undescribable.

A giant caterpillar.. or a towering lobster...

I AM GOGRAM! A voice thundered.

AND I AM GOGRAN! Another voice reverberated

They came nearer, in the four-foot heads, many-faceted lemon-yellow eyes, measuring more than a foot across, gleamed and glowered . they both raised their front organs

Vijay was speechless with astonishment Of course he was awed But he was disappointed, too! The aliens had visages of worms not gods. But gradually the extraordinarily compassionate light from those huge lemon-yellow eyes began to penetrate Vijay's mind Oh, what a delicious feeling it was! A sensation which was like a thousand flowers tickling your mind, flowers of knowledge, full of the fragrance of power. Bewilderment gave way to delight and serene confidence. And suddenly Vijay began to understand.

He understood the predicament of the aliens, their noble nature And Vijay was ashamed for his fellow humans. How stupid, how cussedly cunning they all seemed in comparison to the gentle aliens who, by now had begun to laugh A merry infectious laughter which caught up Vijay's mind And he too began to smile

THAT'S THE SPIRIT MY BOY! DON'T BE TOO SEVERE ON YOUR FELLOW HUMAN BEINGS! REMEMBER OUR WORDS! STUDY HARD KEEP YOUR MIND OPEN ESCHEW PREJUDICE AND WE KNOW THIS IS SAD FORGET EVERYTHING

Then outlines began to fade and the soul-searing strains of that unearthly music began to reverberate throughout the shining Chitar

GOODBYE FAREWELL GOODBYE FAREWELL

Concluded

Programs for Schools

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Continued from page 63

1. Hedophyllum sessile: — C: Or sea cabbage, is a brown alga of the north Pacific, characterised by a compact mass of fronds resembling a cabbage. The sea walnut, is a comb jelly belonging to a phylum of marine invertebrates known as *Ctenophora.* It is walnut shaped Any echinoderm (i e marine invertebrate with an internal skeleton and a water vascular system) having a long leathery body with tentacles around the anterior end can be called a sea cucumber. Sea cucumbers belong to the class *Holothuroidea.* In contrast the sea onion *Urginea maritima* is a liliaceous plant of the Mediterranean region. It yields medicinal squills.

2. Musca domestica: — B: Is the common house fly. *Musca* is the Latin word for fly. It is derived from the Sanskrit *Makshika* (fly) Though all the four alternatives given share the common suffix "fly", not all of them are "true flies". The term "true fly" is strictly applicable only to members of the order *Diptera* to which the house fly and fruit flies belong. This is one of the largest insect orders numbering more than 85,000 species. Butterflies belong to the order *Lepidoptera* (100,000 species) and dragon flies to the order *Odonata* (5,000 species)

5. Homo habilis: — D: *Homo* is a Latin word meaning man Habilis is derived from an old French word *habillement,* meaning skilful *Homo habilis* refers to tool making man who is believed to have existed some 1 75 million years ago and to have preceded *Homo erectus* or the first 'true man on the evolutionary ladder. He was followed by Neanderthal man some 35,000 years ago Neanderthal man *Homo neanderthalis* and modern man *Homo sapiens* coexisted for some time between 150,000 to 5,000 years ago, in Europe, Africa the middle and Far East

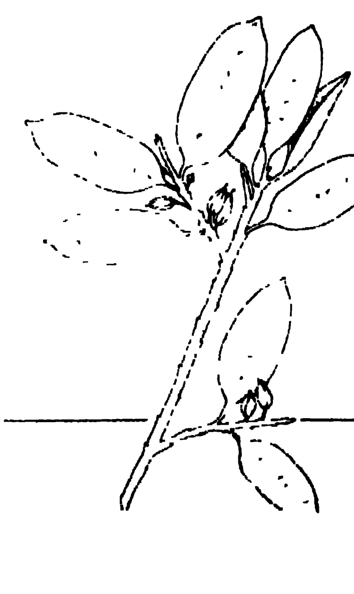
R WHITAKER

3. Naja (Ophiophagus) hannah: — D: Is the king cobra, the largest and most aggressive of all the venomous snakes. The word *naja* is a Latinised version of the Sanskritic *naga* meaning snake. It represents the genus to which the cobra belongs. The king cobra, or the hamadryad grows to a length of more than 15 feet. It attacks even if unprovoked and feeds on other snakes. It differs from the common cobra in that it is 'unspectacled' but has white bands across its hood The king cobra can raise its body upto a height of about one metre and so can strike a man even at thigh level, whereas other types of snake bites usually occur at the ankle

4. Leo tigris: — D: The tiger, is a big cat, belonging to the family *Felidae* and the genus *Leo.* The word 'tiger' is defined to include the jaguar, thylacine and other animals resembling the tiger. From the point of view of internal structure the tiger and lion *(Leo leo)* are almost indistinguishable They have been mated successfully in captivity. The offspring of a lion and a tigress is called a liger and that of a tiger and a lioness a tigon.

The term panther includes big cats like the cougar, the puma *Felis concolour* and the leopard *Leo pardus.* The genus name *Panthera* was formerly used in the nomenclature of all the big cats, but this term is obsolete and now the generic name *Leo* is used.

A P



6. Erythroxylon coca: — C: Is the botanical name for the plant from which cocaine is extracted The plant is native to Bolivia and Peru where it is known as *cuca.* The Spanish adaptation of this word is *coca,* the word from which cocaine is derived. Cocaine is a bitter crystalline alkaloid which has a highly toxic action on the central nervous system, resulting in hallucination, habituation followed gradually by mental deterioration and eventually death.

7. Citrus paradisi: — B: Grape fruit or pomelo. *Citrus paradisi* is a citrus fruit belonging to the genus *Citrus*, which includes the citron, lemon *(Citrus limon)* and the orange

8. Nelumbo nucifera: — A The Indian lotus *Nelumbo nucifera*, literally meaning the lotus of the Hindus', belongs to the family *Nelumbonaceae*, a family of aquatic herbs of the order *Nymphaeales*. The lotus figures in both Egyptian and Indian folklore. The lotus plant is represented in an ancient Greek legend as inducing luxurious dreaminess and a distaste for an active life.

MICHAEL RODRIGUES

9. Solanum jasminoides: — B: Is an ornamental woody vine, native to Brazil. It is known as the potato vine, having an attractive white, star-like inflorescence. The world solanum is derived from a Latin word meaning 'night shade'. It includes plants of the order *Solanaceae*, also known as the 'Potato order'. The potato *Solanum tuberosum* and the sweet potato *Ipomoea batatas* are grown for their edible tuberiform stems and roots respectively. Potato bean is an uncommon name for ground nut or peanut *Arachis hypogaea*

DHANANJAY

10. Prunus armeniaca: — C Or the apricot, belongs to the same genus as the peach *(Prunus persica)* and the cherry *(Prunus avium)*, the words 'prune' and 'plum' also refer to members of the genus *Prunus*. *Prunus* is derived from the Latin word meaning plum tree. This in turn is adapted from a Greek word meaning sloebush. The epithet sloe eyed beauty refers to blue black eyes, coloured like wild plums. In botany it represents a genus of trees and shrubs of the natural order *Rosaceae*, including the common sloe, bullace, plum, apricot, cherry and other species bearing drupaceous fruits

DHANANJAY SASTAKAR

Win a prize!

FIND the odd man out from the ten items given by us and explain why you made your choice. Also give us the common names of the following species. *Mentha piperita, Hippocampus hudsonius, Echinarachnius parma, Oryza sativa, Formica rufa, Paradisaea minor*. Send your entries on or before 5 September, 1984. The winner gets a full years free subscription to SCIENCE TODAY.

The Winner

AFTER the lukewarm response to the March Quiz, the reader's enthusiasm for our April competition was a pleasant surprise. We asked you for a list of words with the prefix 'iso'. Thanks for inundating us with entries. A substantial number of lists crossed the hundred words mark. But, the winner Ajay Jain of Patna, with his list of 205 words, won hands down!

PHYSICS AND DARWIN'S THEORY

DARWIN'S book, on the Origin of Species, was published in 1859. It is perhaps the most influential book that has ever been published, because it was read by scientists and non-scientists alike, and it aroused violent controversy. Religious people disliked it because it appeared to dispense with God, scientists liked it because it seemed to solve the most important problem in the universe, the existence of living matter.

What has this to do with physics? Is it not biology? Perhaps so, but it is now strongly believed that physicists should be prepared to turn their minds to any problems to which they can make contributions. The work of Perutz and Kendrew on the structures of haemoglobin and myoglobin, and of Hodgkin and Huxley on nerve and muscle, shows that physical scientists can make important contributions to biological research. We have always been slightly suspicious of the theory of evolution because of its ability to account for any property of living beings (the long neck of the giraffe, for example). We have therefore tried to see whether biological discoveries over the last thirty years or so fit in with Darwin's theory. We do not think that they do.

Darwin himself had considerable doubts, his book contains a chapter called 'Difficulties on theory'. Of particular interest to the physicist are his remarks about the eye: "To suppose that the eye, with its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection, seems, I freely confess, absurd in the highest possible degree." Nevertheless, he goes on to suggest how an eye could have developed from a simple light sensitive organ, but there is no evidence that it did develop in that way.

Relevance of recent research

In 1859 the general principles of the body were understood. The functions of the various organs were known but not the details of their operation. In the last thirty years we have learned a great deal about life processes (still a minute part of what there is to know!) and it seems to us to be only fair to see how the theory of evolution accommodates the new evidence. This is what we should demand of a purely physical theory.

The theory does not stand at all. We will take only one example—breathing. Darwin knew, of course, that we draw air into our lungs, that the oxygen in it is somehow incorporated into our blood, and that the heart pumps the blood round our bodies so that the oxygen can perform its required services. He had no idea how complex the whole operation is. We know that it involves a complicated chemical, haemoglobin, a molecule of which contains several thousand atoms. Thanks to the work of people such as Perutz and Kendrew, we now know the molecule is constructed and we know the conditions under which the oxygen molecules are held and released. We still do not understand the nature of the forces; they are necessarily very delicate, and for this reason a large molecule is needed.

Darwin says "If it could be demonstrated that any complex organ existed which could not possibly have been formed by numerous, successive, slight modifications my theory would absolutely break down." We know that haemoglobin is not an organ but the principle is the same; we do not see how the haemoglobin molecule could have evolved. It is true that haemoglobins in different animals are not identical, but they are all about equally complicated.

Thermodynamical considerations

The beautiful and meticulous system which we call a living being is an ordered one; each atom must be in its right place. Generally systems tend to disorder — to have maximum entropy. Living beings seem to disobey this rule. There is however a well known phenomenon that does defy the rule—crystallisation. It may be thought that this is a simple analogue from which the principles of life may be developed. We know, however, that crystallisation occurs because entropy S is not the deciding factor; internal energy U is also important. The quantity that must be minimised is the free energy, (U - TS), and U is small for a crystal because the crystal atoms are carefully packed together. As the temperature T increases, S becomes more important, and the crystal first becomes liquid (usually) and then gaseous. Therefore, if we wish to regard the birth of an animal as regulated by the principles of thermodynamics, we must believe that the developing arrangement of atoms is that of lowest internal energy. My mind boggles!

Alternative to Evolution

If living matter is not, then, caused by the interplay of atoms, natural forces and radiation, how has it come into being? There is another theory, now quite out of favour, which is based upon the ideas of Lamarck: that if an organism needs an improvement it will develop it, and transmit it to its progeny. We think, however, that we must go further than this and admit that the only acceptable explanation is creation. We know that this is anathema to physicists.

An animal — particularly the human animal — is a beautiful example of a carefully contrived and subtly engineered design. The word 'design' comes naturally even in evolutionist books. The Designer must know infinitely more science than we shall ever know. He started off with a few simple examples and, learning from them, introduced new and improved species.

We find these ideas comforting, for if we do destroy ourselves, a superior model will be created, whereas according to the theory of evolution we are doomed. Darwin was fond of the quotation *'Natura non facit saltum'* (Nature does not make jumps). I wonder what he would have thought of the quantum theory!

Murli Dhar Tiwari

Dr. Tiwari is Reader and Head of the Physics Department, Garhwal University, Srinagar (Garhwal), UP

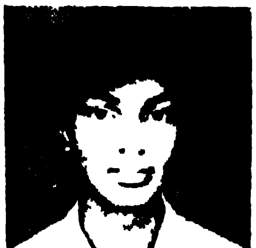
I.I.T. JEE 1984

Once again, our students have secured the top positions at the 1984 I.I.T. JEE continuing our proud tradition of record-breaking results. 84 out of the first 100 ALL INDIA RANKS were bagged by our students led by Navin Budhiraja who secured the ALL INDIA FIRST RANK!

42 of our students listed below, are ranked within the first ALL INDIA 50!

Heartiest congratulations to all our successful students!

NAVIN BUDHIRAJA



B S PRASAD

B ASHOK

A J GANESH

S V KRISHNAN

Sr No	Name	Place	All India Rank	Sr No	Name	Place	All India Rank
1	Navin Budhiraja	Bhilai	**1st**	22	Anshul Gupta	New Delhi	**27th**
2.	B S Prasad	Bhilai	**3rd**	23	Dipankar Chatterji	Calcutta	**28th**
3	B Ashok	Bangalore	**4th**	24	Sanjiv Narayan	New Delhi	**29th**
4.	A J. Ganesh	Madras	**6th**	25	B S Anil Rao	Bangalore	**31st**
5.	S V Krishnan	Madras	**7th**	26	R Venkateswaran	Bombay	**32nd**
6.	Sharat P Hegde	New Delhi	**8th**	27	R Hari Prasad	Ranchi	**33rd**
7	Ashish Gupta	Dehradun	**10th**	28	O N Babu Narayanan	Kalpakkam	**34th**
8	Narendra V Shenoy	Bombay	**11th**	29	Rajeev R Rastogi	Bombay	**35th**
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10	Dinesh H Katiyar	Bombay	**13th**	31	Subrata Mitra	Calcutta	**37th**
11	I Ashok	Vizag	**15th**	32	Vipul M Shah	Lucknow	**38th**
12	Dinesh Das	Kharagpur	**16th**	33	Amitabh B Sinha	Calcutta	**39th**
13	Deepak Chandra Tushar	Dehradun	**17th**	34	H Venkatesh	Madras	**40th**
14	Manas Chandra Saksena	Lucknow	**18th**	35.	Vipul Kashyap	Bombay	**41st**
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20	Naresh Chand Gupta	Lucknow	**25th**	41	B R Bhargav	Bombay	**49th**
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RADICAL

... why 'TOUCH ME NOT' shies away

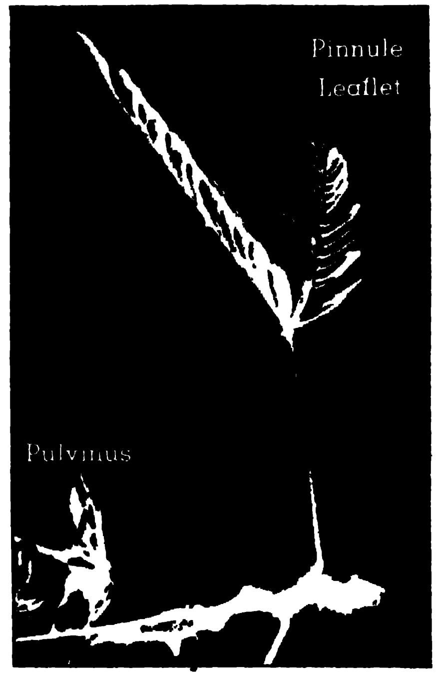
THE *Mimosa pudica* plant popularly called 'touch me not' and *lajavanti*, *lajamani*, *lajalu*, etc. in some Indian languages is also known as the sensitive plant as it shows a very quick response to stimuli like touch and heat. Several weeds like *Biophytum sensitivium*, *Desmanthus planus* and a floating plant like *Neptunia oleracea* are also known as sensitive plants But it is the 'touch me not' which has got maximum scientific attention.

As a matter of fact all plants show some response, quick or slow to various external stimuli like light, water, gravity, heat and touch Stimulus is defined as the change in the environment Responses are expressed in two types of movements -unicellular or colonial Mobile plants bodily move towards or away from the stimulus But higher plants which are rooted to one spot, respond merely by a curvature of the stimulated part

All movements depend on the magnitude of the stimuli and also on the irritability and sensitivity of the protoplasm in the stimulated cells Health of the plant and the nourishment it gets also play their role in the expression of movements The movement of curvature towards or away from a unidirectional stimulus is called a tropic movement If it is unrelated to the direction of stimulus, the movement is called a nastic movement Bending of a stem at its apex towards the light, coiling of a tendril around a support are examples of tropic movements and the opening of flower buds due to light, folding of leaflets during nights are some examples of nastic movements 'Touch me not' shows similar nastic movements in response to mechanical stimulus like touch

Mimosa pudica is a small herbaceous plant The stem and leaves are fully coated with hairs. The main axis of the leaf bears a pair or two of pinnules and each pinnule bears some 10 to 20 pairs of small leaflets. The swollen stalk of the leaf (= petiole) is called pulvinus Even the bases of the stalks of pinnules and leaflets (= petiolule) are swollen and act as the pulvinus (Fig 1)

If any part of *Mimosa* leaf is touched, the stimulus is conducted to the base of the subjected pinnules and then to other pinnules If the stimulus is of slightly greater magnitude, its effect is carried right up to the main pulvinus of the leaf and the response is shown by the entire leaf The movement in *Mimosa* is rapid and response is seen in a second or two. The stimulated leaflets and pinnules close up in pairs and droop down in succession from the tip



S N KULKARNI

***Mimosa* plant, before and after stimulation**

basewards If the stimulus is strong enough it affects even the main pulvinus of the leaf. Thus the entire leaf gets affected and bends downwards. The process begins with the folding of the leaflets followed by the folding of the pinnules in pairs and ends with the bending of the entire leaf

This movement is caused by differential changes of turgor on two sides of the pulvinus which show different types of cellular organisation The lower half shows thin walled loosely arranged parenchymatous cells with several large intercellular spaces whereas the upper half has parenchymatous cells which are comparatively thick walled and compactly arranged with smaller and fewer intercellular spaces

On stimulation, a series of changes take place at the cellular level in these parenchymatous cells Water from the cells of the lower half of the pulvinus moves out to the intercellular spaces, resulting in a fall of turgor in these cells Cells on the upper half of the pulvinus become more turgid by absorbing this water from the intercellular spaces and consequently are in a stretched condition whereas the cells of the lower half become flaccid The weight of the leaflets and pinnules presses the petiole downward, the flaccid cells shrink and the leaf droops Eventually, the cells of the lower half resorb water from the surrounding, become turgid and the leaf returns to its normal position.

This pulvinus activity depends on the hydration and dehydration of proteins present in the cells It is presumed that adenosine triphosphate (ATP) provides the necessary energy It is also suggested that the whole mechanism operates under the influence of some hormones produced in the stimulated part and which travel to the pulvinus through the xylem Perhaps, some osmotically active substance, probably potassium ions escape from the cells into the intercellular spaces This results in the contraction of the stretched cell walls to force some water of the cell sap outside. Once the stimulus is removed, this active substance reenters the cell sap increasing the osmotic pressure of the cell sap Consequently the cells resorb water from the surrounding intercellular spaces and become turgid

There are a number of hypotheses to explain the phenomenon but it is universally agreed that for some reason or the other the lower half of the pulvinus loses water, the cells become flaccid and the part droops Such type of nastic movement, brought about in response to the external stimulus of touch is called seismonastic movement

Manohar M. Moghe

Dr Moghe is Head, Department of Biology S S & L S Patkar College, Goregaon Bombay

GOOSEBERRY PRICKING MACHINE

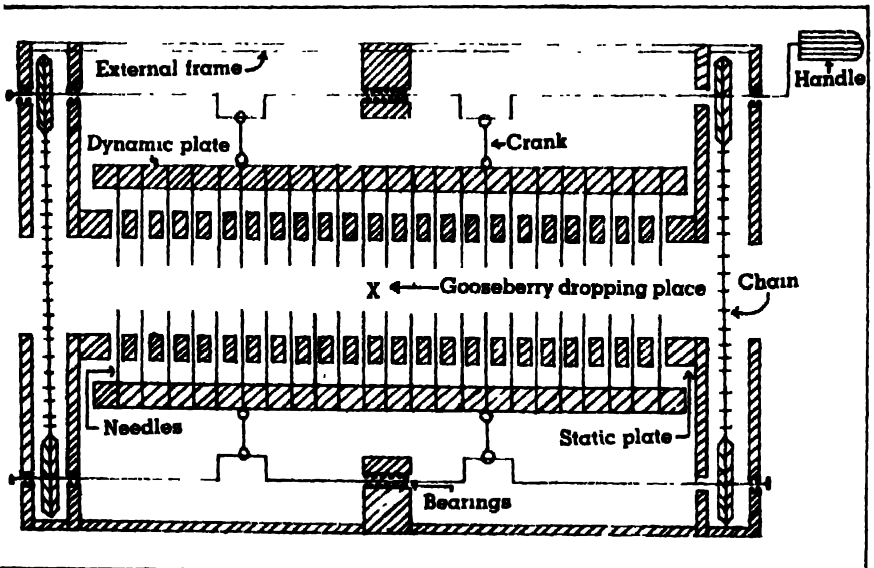


Fig. 1: Internal structure of the machine

INDIAN gooseberries (*amlas*) are often used to prepare delicious jams and pickles. However pricking them for this purpose can be hazardous in the absence of a convenient tool. The machine described below works efficiently to prick gooseberries on a large scale.

The machine consists of four movable plates and a perforated cylinder with a thick lining. The plates fitted with needles of definite dimension are placed around the cylinder Every plate is connected with a separate crank which has a pinion on its shaft. A chain connects all four pinions (*see Fig. 2*) thus connecting the four crankshafts with each other If one crankshaft is rotated with the help of a handle, all four rotate simultaneously.

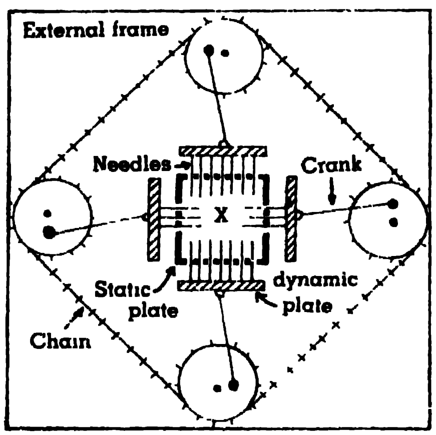


Fig. 2: Angular view

How it works

The machine is placed on an inclined surface The cranks are rotated using the handle and simultaneously the gooseberries are dropped from the top of the cylinder (*see Fig 1*) The plates begin to move to and fro. The needles penetrate through the holes in the cylinder and prick gooseberries passing through it

The needles are constructed in such a way that when they are inside the cylinder, there is a gap of the size of an average gooseberry nut between them And when they are completely out of the inner surface of the cylinder, their tips continue to remain inserted in the thick wall of the cylinder.

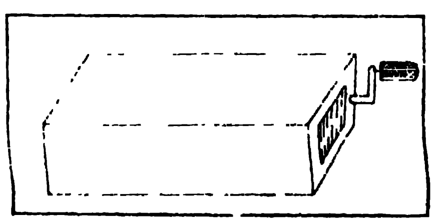


Fig. 3 External view

The machine offers the following advantages.

1. The machine can prick about 100 gooseberries in the same time (three minutes) that it takes to prick a gooseberry manually.
2. During manual pricking there are chances that the juice spatters to the eyes and causes irritation. The machine solves this problem as it is covered from all the sides.
3. The possibility of injuring oneself with knives. forks or needles used for manual pricking is eliminated by the machine.

Manoj Kumar Patairiya

Mr. Patairiya is editor of Vigyanpuri*, a popular Hindi science magazine, and has several inventions to his credit.*

Pilots get new eyes

A PILOT can now concentrate on his flying without having to look down at the instruments in the cockpit. A micro head-up display (HUD) system incorporated in eyeglasses by Hubert Upton of Bell Helicopter Texbron, in the US, enables a pilot to 'see' his instruments without looking at them. Superimposed on his view are vital instrument readings such as airspeed, altitude, compass heading and artificial horizon.

The new eyeglasses work like the fixed HUD system found in modern jet fighters. But their advantage is that the image appears wherever the pilot looks. The glasses could be conveniently used by civilian pilots as they are light and less costly than a fixed HUD.

A fibre-optic ribbon transmits the information to be displayed to a tiny mirror at the centre of one eyeglass lens. The mirror, only one mm in diameter, is too small to be seen, but reflects the image into the pilot's eye, creating the illusion that the readings are projected in front of the eyes.

Originally developed for helicopter pilots, the micro-HUD glasses have many other ingenious applications. A surgeon could watch his patient's vital signs without moving his head. An engineer or lab-technician could check on instrument readings while totally concentrating on his work. Even physically handicapped persons could benefit from these glasses. A sound-sensitive version, converting speech to symbols, could enable a deaf person to "read" another's lips without even looking at them.

Nagpur 21.00 H (IST) As on 15 July 1984
Magnitude limit [illegible] Latitude [illegible]
Longitude [illegible]
Sidereal time [illegible]

SKY IN JULY 1984:
All planets assembling in the evening sky

BECAUSE of the full onset of the monsoon over the Indian subcontinent, July and August will be the worst in the season for any good sky-watching. Unfortunately, it is in July and August of this year that all the nine planets are going to assemble in the evening sky. In one extreme, there will stay Venus, closest to the Sun, and Jupiter in the other, measuring an arc of about 110 degrees. By the end of July, Mercury will be seen very close to Regulus in Leo, Venus about 15 degrees below Mercury, that is, somewhere between Cancer and Leo. Mars will be present high up in the south by sunset in the constellation Libra. Jupiter will shine dazzlingly over the constellation Sagittarius in the southeast. Saturn will still be found in the right half of Libra. Uranus will be in Scorpius, Neptune in Sagittarius, and Pluto in Virgo. It will be very difficult to see them even with a good pair of binoculars.

Venus will begin to reappear in the evening sky with the naked eye from about July 25th onward. About 30 minutes past the local sunset, Venus will barely be visible to the naked eye only about four degrees above the point where the Sun will have already been set. Once Venus appears in the evening sky, it will continue to stay in the evening sky for about eight months. It will become brighter everyday and also gain height till the separation between the Sun and the planet reaches a maximum of about 48 degrees. Mercury will easily be seen with the naked eye by the end of the month, at about an hour past the local sunset. It will distinctly appear somewhat [illegible] in Leo. [illegible] of motion (eastward) [illegible]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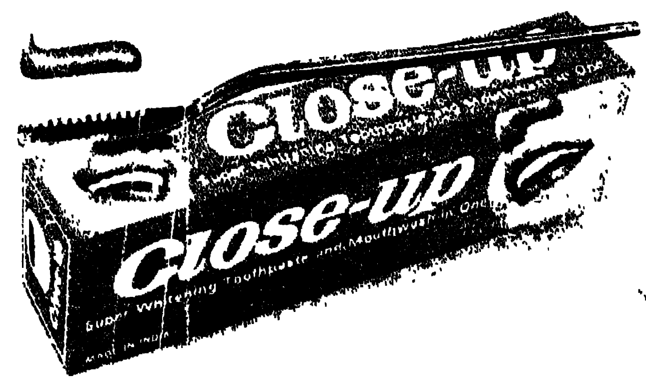

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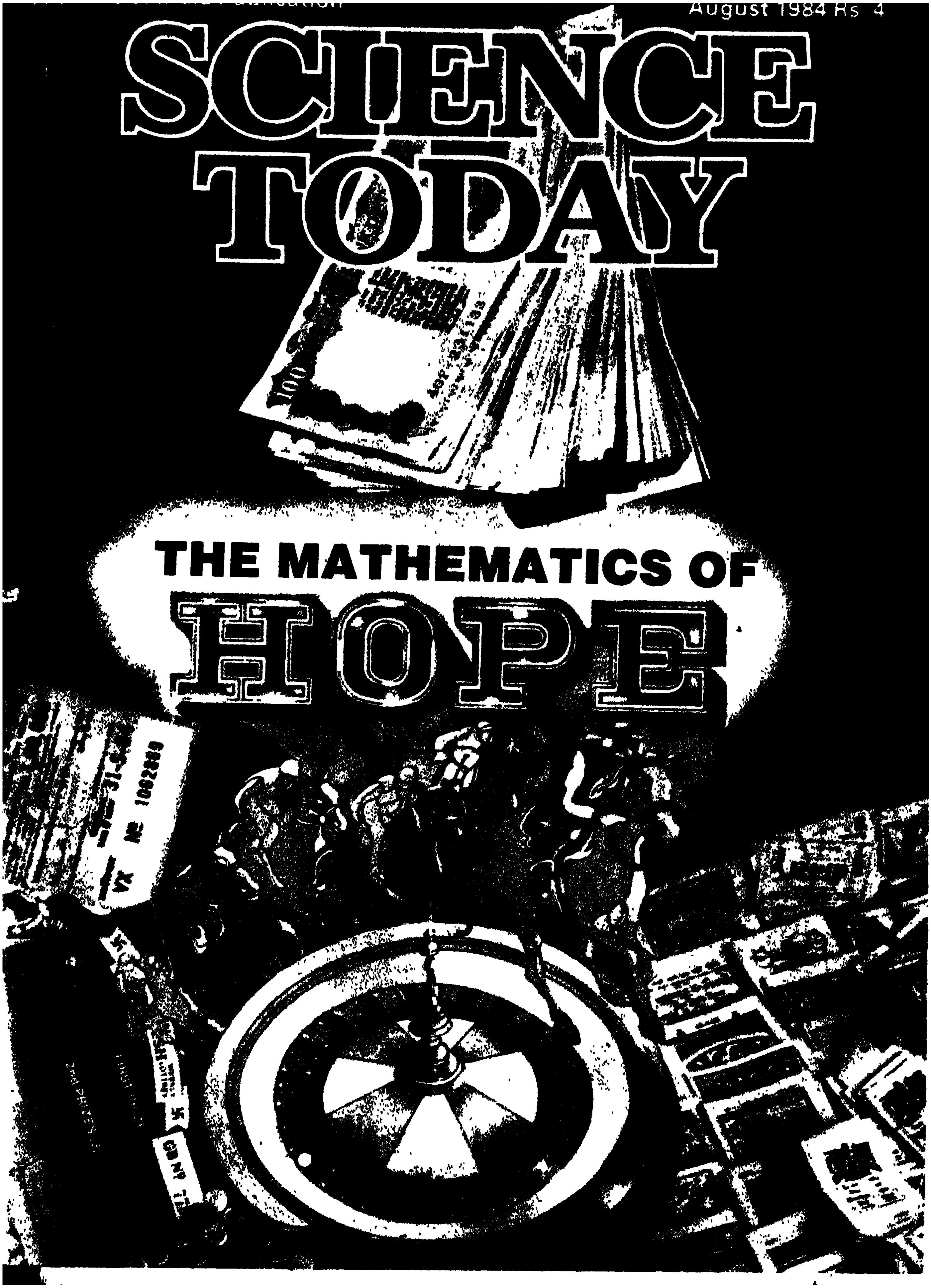
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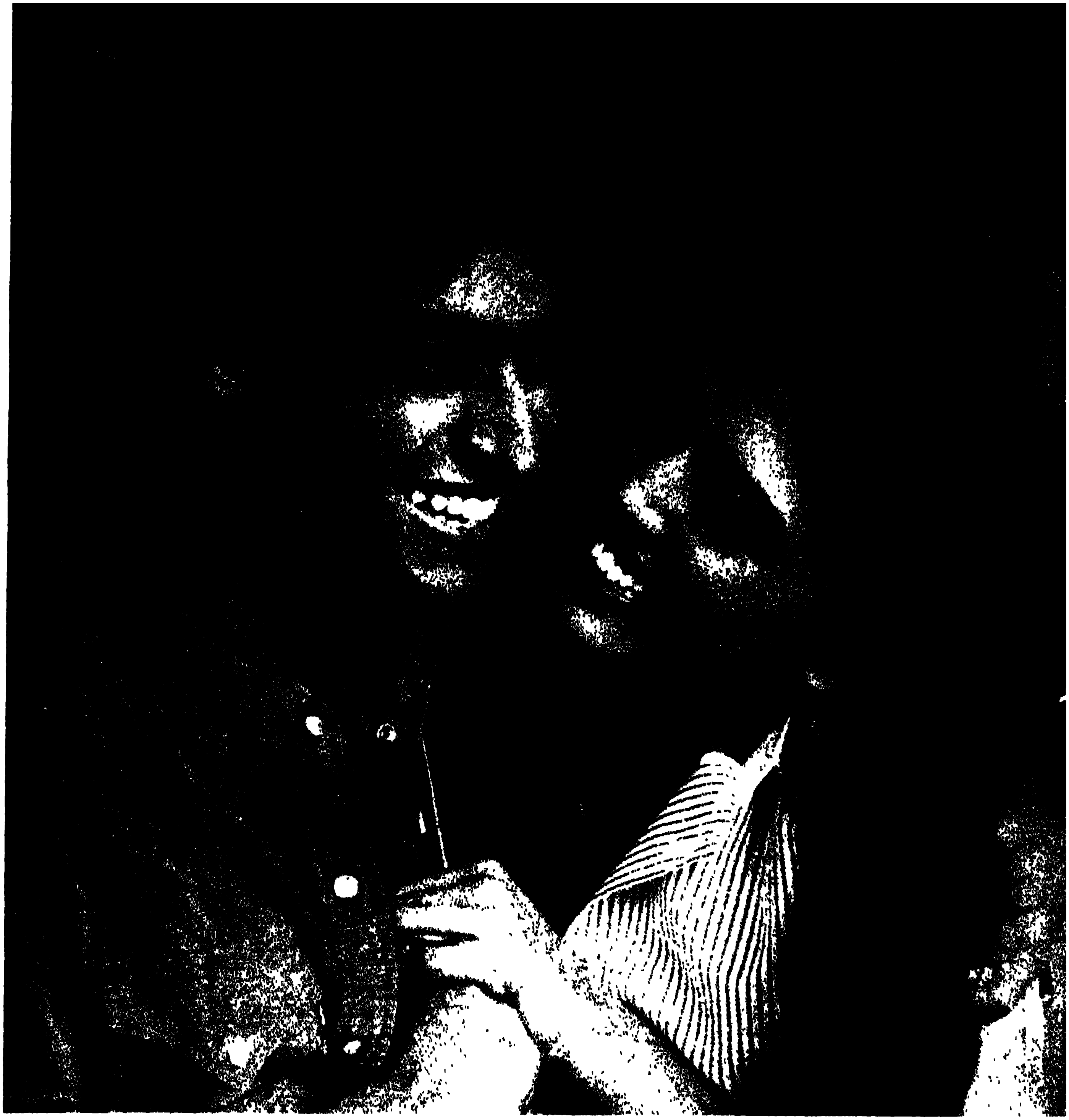

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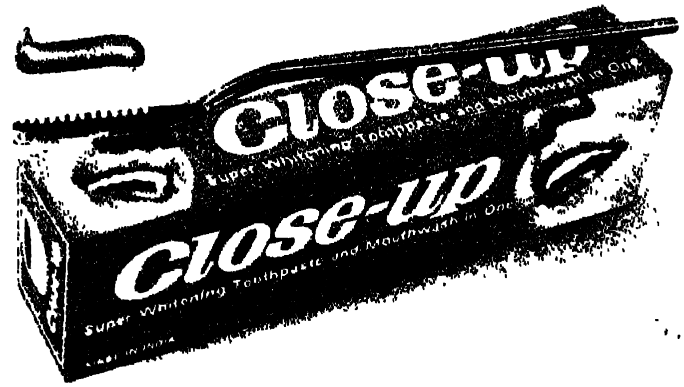

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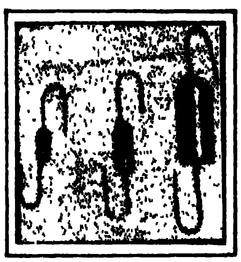

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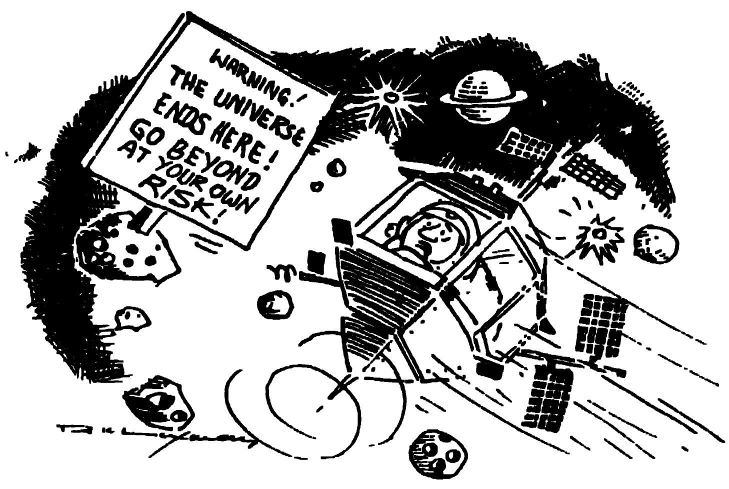
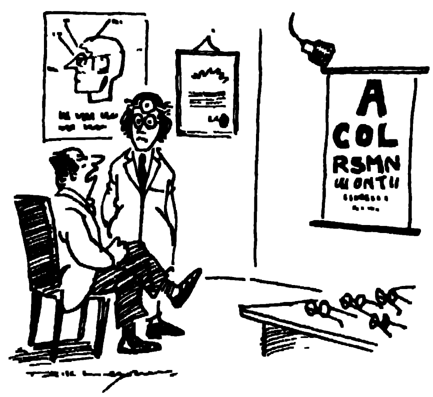
Features

COVER ILLUSTRATION
BY FRANCIS D'SA



Ground Control, do you know where the brakes are in this?



Of course I can read. But can you? I am told there are quite a few bogus degrees floating around here!

R. K. Laxman

No need to restore it, Professor. We just discovered it's a recent piece—dated January 1984!

No, thanks. I just had it at the last mirage!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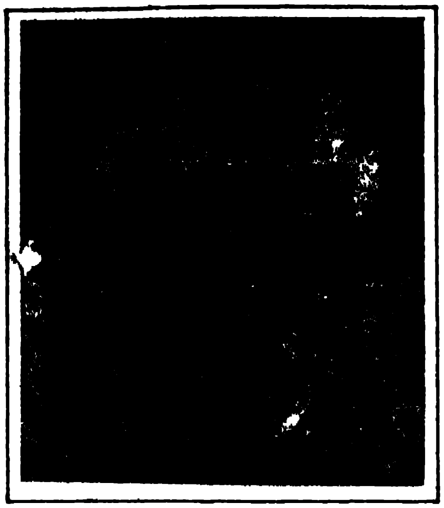

SCIENCE TODAY

Vol. 18 No. 8 August 1984

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ANY report on the activities of our scientific institutions appearing in the press usually meets with disapproval of the scientific community. The main complaint is that these articles grossly overstate their case. The charge is specially acute whenever a critical evaluation of the shortcomings of the projects or possible hazards to the populace at large is presented. The scientists accuse the journalists of giving in to sensationalism or laying more stress on impact rather than accuracy. Both, scientific research and science journalism are relatively young in our country. However, even in those parts of the world where these have a longer standing, the situation is not very different.

The American chemical fraternity is considerably annoyed at the persistent reports that have appeared in the press or television there on dioxin, acid rain or Love Canal. By emphasising these issues, it was felt, the public is being misinformed, nay misguided, about the chemists and their works.

To remedy this situation, a task force consisting of scientists, journalists and other experts in the fields of public health and welfare was constituted. Its report, which was recently released, should, in addition to making interesting reading, provide guidelines to all concerned.

The report is certainly not unanimous. None other than the Chairman has filed a dissenting note. But the consensus is that considering the constraints under which they have to perform, the newsmen have done a commendable job in reporting the risks. The group recognised that the journalists have the onerous task of simplifying complex technological information riddled at times with inscrutable jargon and that too without slipping on the deadline. Although the possibility of a personal and/or institutional bias cannot be totally ruled out, the argument that journalists should refrain from or demonstrate greater restraint in reporting the ill effects, dangers or failures was rejected by the majority.

This last point needs to be stressed in the context of our social structure. With the public largely uninitiated and even apathetic, it is left to the members of the fourth estate to make people aware and inform them properly. That this should be done in an objective and responsible manner no sane journalist would deny. The only consideration should be the good of the many.

But it is easier said than done. To achieve this goal a better rapport has to be established between scientists and journalists. The journalists have to learn to respect the innate caution on the part of the scientists and their tendency to talk in terms of probabilities rather than certainties. On the other hand, these should not be stretched by scientists to become overcritical or secretive. They also have to appreciate that the journalists too have a code of ethics albeit different from the one they adhere to.

The primary function of the press is to inform, perhaps suggest the public a stand it should adopt, but not coerce it into accepting that view. This does not imply, however, that the task of informing should not be done without fear.

EDITOR

UNSAFE CONTAINERS

The article "How safe are food containers?" (May, 1984, page 41) says—aluminium utensils are not harmful. Are they? Recently, there has been a controversy about the role of aluminium (*American Health*, 2, 5, 48-54, Sept/Oct. 1983). It has been shown that aluminium has a major role in Alzheimers' disease and causes colitis in some individuals. Hence, aluminium utensils cannot be considered entirely harmless, especially when Indian cooking often involves the use of acidic medium.

B. BOWONDER

Chairman,
Centre for Energy Envt & Tech,
Administrative Staff College of
Bella Vista, Hyderabad-500 475

Harnessing the enzymes

This refers to our article 'Harnessing the Enzymes' (June, 1984) Some inaccuracies have crept in during the editorial processing of the article. These are as follows:

The statements in the box (p. 57) which are not entirely correct are: (a) the enzymes are not only involved in "breaking big molecules into smaller ones", but they can also synthesise larger molecules from smaller ones, such as proteins, polysaccharide, nucleic acids, etc., and (b) para 2, a particular enzyme can react only with a specific substrate and not with "particular kind of substance, or a group of closely related substances".

P. 58, under "Immobilisation techniques", para 2: The sentence reads "The solid support is provided by ion-exchangers *like* charcoal, silica gel, glass beads plastic-like resins, etc." The word *like* should be deleted so that it will not give an erroneous statement.

P. 59, middle column, para 2: the sentence reads "Thus, starch can be *attached* to glucose by the use of a single enzyme like glucoamylase In fact glucoamylase causes breakdown of starch to give rise to glucose molecules. The word "attached" can be replaced by "converted".

G. B. NADKARNI

Head, Biochemistry & Food Technology Division,
Bhabha Atomic Research Centre,
Trombay-Bombay 400 085

Aeromodelling

The article 'Build your Aeroplane and Fly (March, 1984) by Sylvestor Lobo is, I am afraid, sketchy and too simple to evoke much enthusiasm in persons, especially those who never had any idea that a thing called aeromodelling exists. Moreover, it is not so simple and easy as it sounds/reads for one to get started, as my own experience shows.

The problems begin at the very beginning: where to look for more information or assistance. Add to it the lack of availability of kits and their (sometimes) high costs—even for the simpler glider kits and the control-line ones. Forget the radio-controlled models they are for the blessed ones. They are prohibitively costly! A 3/4 channel transmitter unit alone costs around Rs. 5000, not to speak of the receiver, servos, etc.

Even if one gets a model, the finishing is a problem. The kit's quality is sometimes downright rotten. Want some spares or bits and pieces to your system/model? Forget it. It is easier to replace the whole set!

My own interest was kindled by a couple of old issues of *Radiomodeller*—a British magazine. Their supply in Hyderabad is unpredictable and erratic, and there are no such Indian publications. The SMAE is defunct and non-existent for all practical purposes. The shops that are supposed to cater for aeromodellers are ill-equipped and useless.

The NCC air wing? They are not interested in hobnobbing with or teaching to a rank outsider. And never count on mail order services of the manufacturing dealers. My repeated letters to the Jodhpur/Calcutta concerns could not even elicit an acknowledgement. My attempts to correspond with other aeromodellers, Indian and foreign, proved to be equally futile.

So, some of my chuck, catapult glider kits and control-line models are now safely in the attic, even without a hope to be finished—unless some 'real' aeromodeller who goes through this letter feels like helping me.

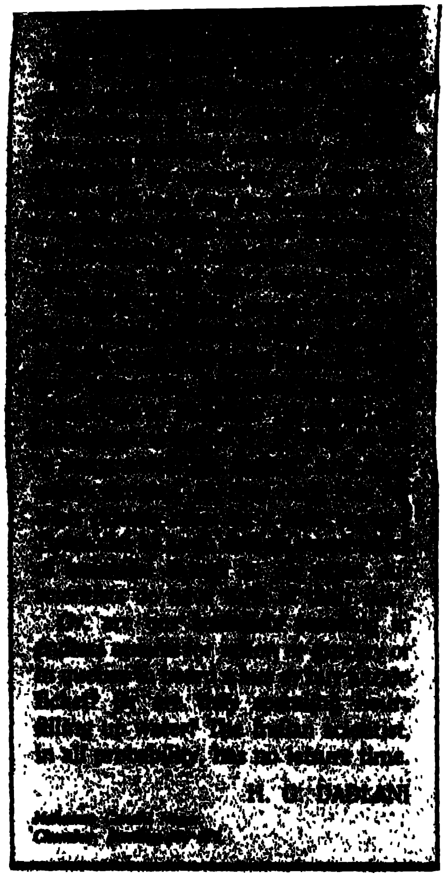
RAJA GOPAL

Kalwakurthi-509 324
Andhra Pradesh

Attention UDCT alumni

The Department of Chemical Technology, University of Bombay, (UDCT) is celebrating its Golden Jubilee from 4th August 1984. A series of programmes, like plenary lectures, seminars and symposia in various branches of technology and chemical engineering, alumni get-together and other celebrations are planned for the Golden Jubilee Year.

We wish to reach our alumni for their active participation in the Golden Jubilee programmes. The Jubilee will also be used to institute programmes for the future



where active and sustained co-operation of the alumni is desired. The alumni and past staff members of the Department may furnish details such as, name, year of receiving degree, branch of study, career profile and other relevant information to Prof. D. V. Rege, Director. UDCT, Matunga, Bombay-400 019.

K. K. TIWARI

Convener, Golden Jubilee Celebrations,
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Lead in auto exhausts

The article "Lead in auto exhausts" by R. N. Khandekar (April, 1984) made an interesting reading. The problem is taking its own toll, and we are helpless spectators. Our metropolitan cities are highly polluted with lead pollution due to heavy traffic and lack of alternative traffic outlets.

The author has, however, ignored to discuss the situation in Russia, and the protective measures used by that country. Roads with heavy traffic are provided with alternative traffic diverting outlets and automatic indicator units alongside the roads, signalling the concentration of smoke and noise generated by automobile exhausts. If the concentration of smoke and noise is high at any place, especialy at pentagons, then the traffic is signalled to stop, and diverted. This greatly minimises noise and lead pollution.

N. K. SAKSENA

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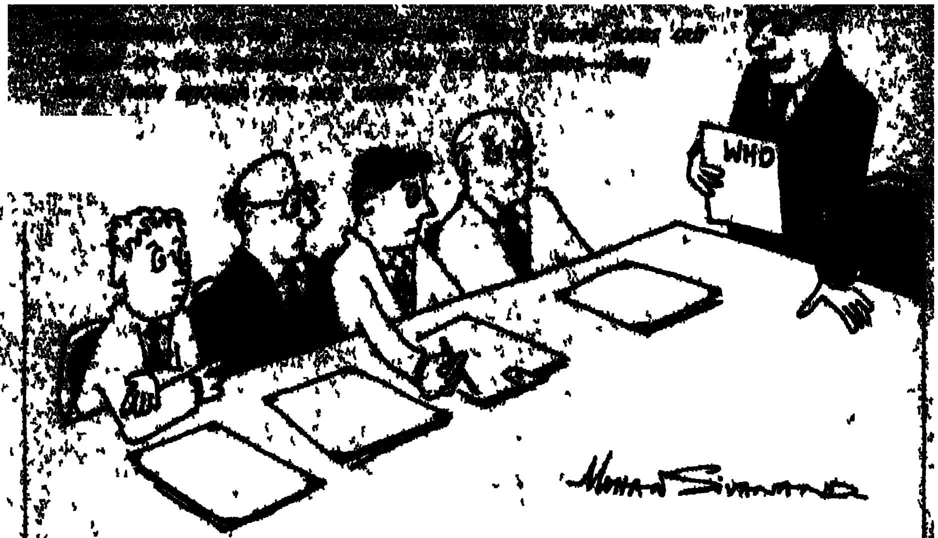
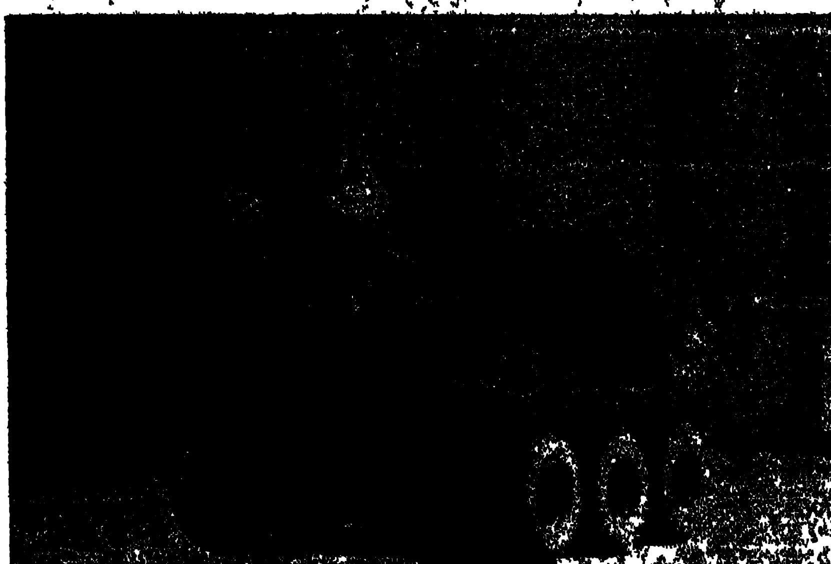


How rice water works in diarrhoea

THAT decoction, the water in which rice is cooked, can cure diarrhoea is well-known in the Third World. This has now been substantiated by medical researchers in India and Bangladesh.

The traditional cure takes the oral rehydration therapy (ORT)—a pre-measured mix of water, sugar or glucose and salts—principle of efficient absorption through the intestinal walls one step further. Unlike sugar, which in excessive quantities can actually aggravate the diarrhoea, rice water releases its glucose slowly but steadily through the gut. Substituted for sugar or glucose, it also makes the ORT mixture more nutritious, provides more energy and reduces the volume of the diarrhoea.

Rice powder is simple to make and is easily available. Scientists are further exploring the potential of other cereals for ORT; what is true of rice may well be true of wheat, maize, sorghum and cassava.



The new killer robot firing test shots

The killer robots are here

ROBOTS capable of killing people are in the making in the US. A prototype of one such machine was completed recently by Robot Defence Systems of Thornton, Colorado.

The killer robot has been named the Prowler (programmable robot observer with logical enemy response). It is a mobile robotic sentry, resembling a miniature tank equipped with microcomputers, artificial intelligence software and distance ranging sensors. Buyers can specify the sensors and weaponry and whether the robot will require human permission (from a remote monitoring station) to open fire.

The new robots, according to manufacturers, will be ideal to patrol airfields, military bases, pipelines, palaces, etc and identify the intruders. Several West [illegible] countries have shown interest in the new product.

Magnetic field therapy for fractures

THE efficacy of a pulsed magnetic field in the treatment of non-uniting fractures was tested successfully in the UK recently.

Patients with fractures of the tibia which had not united for at least 52 weeks were chosen. They were randomly allocated either an active or a dummy magnetic field simulator. Their legs were kept in full-length plaster for 24 weeks. The results showed that fractures in five of the nine patients with working machines and in five of the seven patients with dummy machines united.

The magnetic field therapy was among several other techniques tried to stimulate blood flow to the injured lower part of the ankle and the leg. This part of the body is poorly supplied with blood vessels. As a result fractured bones fail to knit together and damaged ligaments do not get cured as desired.

The therapy involves the affected limb to be placed in a large magnetic coil. When an electric current flows through the coil, the magnetic field produced stimulates a corresponding small electric current in the bone and surrounding tissues.

Breakthrough in identifying arthritis virus

PATIENCE always pays. A tissue taken more than a decade ago from a rheumatoid arthritis patient by Carl Godzeski, a microbiologist at Eli Lilly Research Laboratories in the US, has now helped researchers to identify a virus that may cause the crippling disease.

Godzeski had taken the tissue with the intention of identifying the virus. But he could not for nine long years. He met Robert Simpson, a Rutgers University virologist, in 1979 who agreed to examine the sample with his co-workers.

On examination it was discovered that the agent, which they call RA-1, is similar to parvoviruses — a family of virus rarely found in humans. When it

was injected into mice, the animals developed symptoms similar to those of rheumatoid arthritis, such as stunted growth, crippled limbs and curved spines. An immune response to RA-1 virus was found when mice were injected with tissue of other rheumatoid arthritis patients.

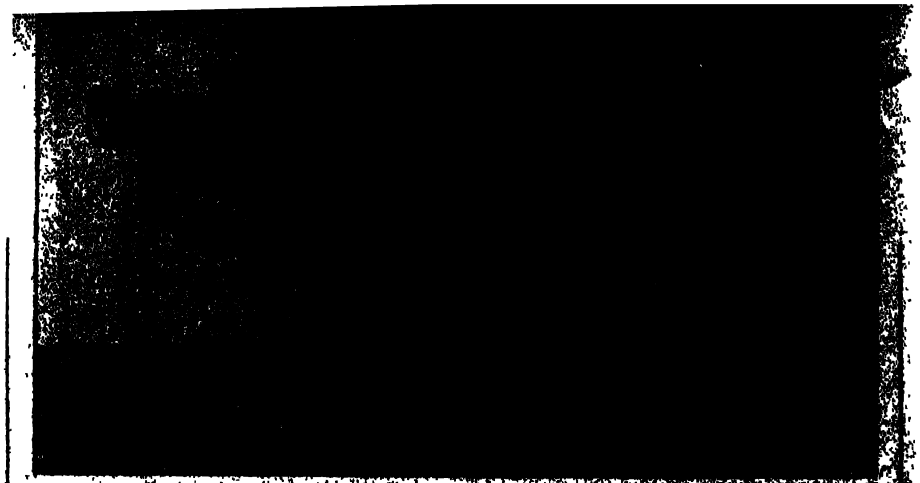
Researchers are not yet sure whether the new discovery will lead to a vaccine because parvovirus do not grow well in cell cultures. However, the discovery itself is a major breakthrough in the search for a vaccine against a disease that keeps five per cent of the world population crippled at any given time.

Stinger missiles fail to 'sting'

THE sale of stinger missiles to Saudi Arabia by the Reagan Administration has no military significance according to a recent report by Claudia Wright in the *New Statesman*. The Stinger is a hand-fired missile that can protect oil installations from air attacks.

The Stinger was developed in the late 1970's by the General Dynamics Corporation to improve on the US 'Redeye', the British 'Blowpipe' and the Soviet SA-7 'Strela'. Soviet missiles were fired in large numbers by the Arab armies during the Ramadan war of 1973. The drawbacks are that firings in desert conditions are deflected by the infra-red sources flashing across the landscape. Its infra-red homing mechanism is too clumsy for most battlefield conditions. So it is difficult to fire at aircraft from a head-on position. Similarly, the 'Redeye' which was despatched to the Chad army against the Libyan air-force showed that not a single missile could be fired properly from the hand-held tube.

The improved Stinger missile was able to strike jet aircraft from the head-on



A hand-held tube fires Stinger missiles

position only if the attacker flew in a straight line, did not manoeuvre at all or did not drop modern heat-flares to deceive the missile. The major flaw is that the warhead is very small, having one-kilogram explosive. It lacks a proximity fuse and it must strike the aircraft in order to detonate. Even then it is not lethal, hence most aircraft can survive the blast.

In bright desert sunlight or over water, the missle has been known to lock on to clouds and other harmless reflectors of the Sun's infra-red rays. The ineffectiveness is not disclosed to the Saudis. The results of the secret tests carried in New Mexico have not been publicly revealed. The American press has not reported the problems with the Stinger and consequently made the missile look more effective than it is.

A watchable crash

HOW to test the structural strength of a nuclear fuel flask? Crash it headlong against a 160km-per-hour train. That is what the Central Electricity Generating Board (CEGB) of the UK has decided to do sometime next month.

The crash will take place on a railway line specially built onto British Rail's high-speed test track. It will be watched by 2,000 spectators, including journalists, seated on a grandstand 300 metres beyond.

British Rail will provide an old diesel locomotive and three passenger cars to the CEGB. The train will be written off in the crash while the flask is expected to remain intact.

Elusive quark is within reach

THE measurement of the lifetime of the bottom quark, one of the most basic bits of nature may soon lead to its companion, the top quark, which has so far eluded scientists.

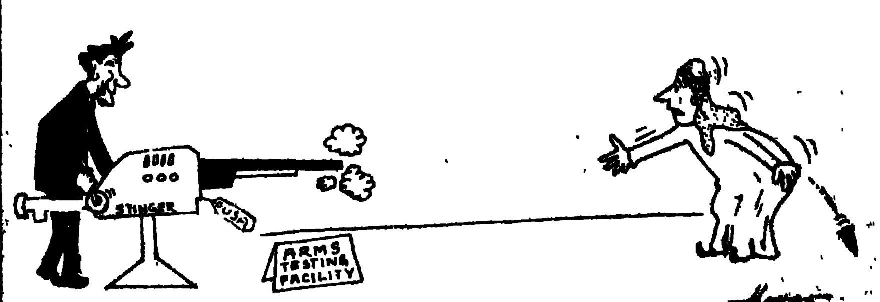
Scientists believe that six types of quarks exist. They are up, down, strange, charm, bottom and top. A triad of up and down quarks make up protons and neutrons. All but the top quark have been found so far.

Researchers in the US in their recent experiments measured the distance a bottom quark travels from the time it is created in a high energy collision of particles until it decays or transforms into a different elementary particle. The flight path led them to determine the life-time of the bottom quark which is only 1.5 picoseconds.

William T. Ford, a University of Colarado physicist, says that the knowledge of the life-time of the bottom quark allows researchers to calculate the mass of its companion. And the top quark's mass reveals scientists the amount of energy they will need in order to find it using a particle accelerator.

Young scientists have bleak prospects

POOR job prospects and low pay scales are forcing bright young scientists in the USSR to quit their posts and take up better paying jobs elsewhere, according to Mr. [illegible], vice-president of



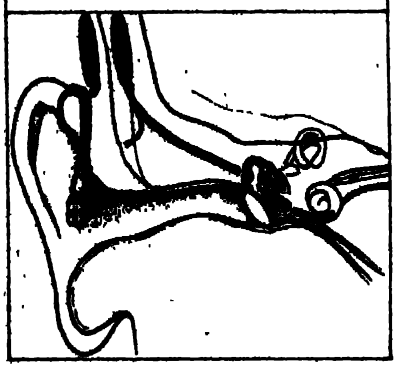
'Ouch! It stings—we'll buy it!'

the USSR Academy of Sciences. He says this may soon lead to a dearth of scientific talent in the country.

One of the main reasons is the frustration of not getting due promotions. Most of the senior scientific posts are held by persons in their 50s and 60s. And it may well be 10 to 20 years before a younger person reached these positions and conducted research of their own choice.

Mr. [illegible], writing in *Isvestia*, cited the example of an astrophysicist who quit research to work as an electrician on a collective farm, where he earned thrice as much.

A similar sort of a situation also prevails in other countries, including India. Rarely does a young scientist in his thirties get an opportunity to conduct the research of his choice. He has to obey the dictates of his superiors till he is well past his creative best. Under these circumstances it is only the sheer persistence and love for science (not considering the complete absence of opportunities in certain very highly specialised areas) which drives the scientists to continue with their research work.



The new hearing aid has a tiny coil implanted in the bone behind the ear which is attached to a wire inserted in the inner ear

Breaking the sound of silence

THE wall of silence that hemmed in five-year-old Tracy Husted has at last been broken. At the age of three, Tracy lost her hearing when an attack of meningitis destroyed the sensitive hair cells in both inner ears. Doctors told her parents, Larry and Noelle of Upland, California, USA, that Tracy's hearing would be lost for ever. Tracy became withdrawn, her speech became unintelligible. Once a happy child, she became a prisoner in a world of silence.

But now a revolutionary new technique has been developed at the House Ear Institute, Los Angeles. Tracy has been given an artificial ear. She can now recite nursery rhymes and dance with other children again. The medical miracle is known as a cochlea implant. Some 200 totally deaf people from the ages of three to 71 have received the device. Tracy was the youngest patient.

Tracy had a one-and-a-half hour operation where Dr. House embedded a coil about the size of a penny behind her left ear. A tiny platinum wire was inserted into the fluid-filled inner ear, or cochlea. Two months later Tracy returned to the institute to be fitted with an external stimulator. The stimulator is a small box which converts sound into electricity. The box is carried by Tracy in a small red backpack.

Total deafness, whether from birth or meningitis, is usually caused by damage to the hair cells in the cochlea. These hairs convert sound into electronic impulses that are carried along nerves to the brain. The stimulator converts the sound into electricity. This is then channelled into the wire device in Tracy's ear. From here impulses are carried along the acoustic nerve to the brain, which perceives them as sound.

Following surgery, Tracy and her family returned to the institute for training and tests. Patients who have had the implant say that they can distinguish between male and female voices. They can also hear their own voices, so they can modulate their tone. Another bonus is that they can hear warning signals and fire alarms.

For some children their first experience of sound can be traumatic. Occasionally they feel an uncomfortable sensation in the middle of their forehead. Gradually they acclimatise themselves to their new ear.

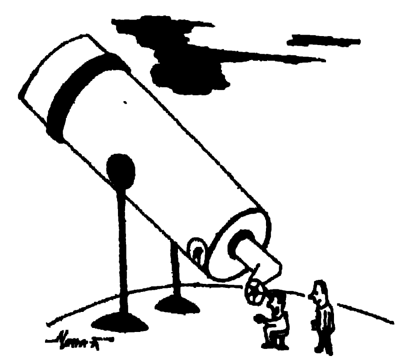
(Asia Features)

—**Francis Rafferty**

Manoeuvrable building houses new telescope

THE Australian National University (ANU) has developed a new optical telescope, considered to be one of the most accurate and efficient ever built, at

The internal structure of the new telescope

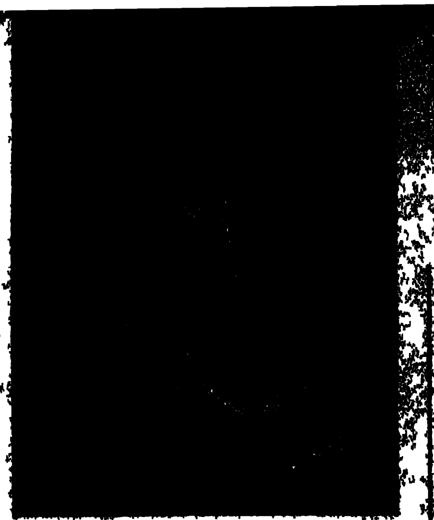


"There's planet Krypton... and whooosh, there's Superman's mother!"

What makes Alex run?

EARLY this year, the US Department of Energy announced it Enrico Fermi Award (1983) for Alexander Hollaender (to share with John Lawrence). This is a rare honour for a practicing biologist who joined the ranks of such luminaries as John von Neumann, Eugene P Wigner, Glenn Seaborg, Hans Bethe, Otto Hahn and Lise Meitner. Even at the age of 85, Hollaender moves on a cinder track and so one may ask what makes Alex run? Is it the gilt-edged insecurity of an immigrant which fuels one to be more than twice as useful as any other native to his country or is it his personal style of restlessness and overachieving? He is still organising symposia and editing books, keeping an eye on the future developments in life sciences and on protection of environment. As a general editor, with a streak of 28 volumes in Basic Life Sciences Series of Plenum Press alone, he has almost become a one-man industry. Yet bringing out such a large number of volumes may be only an encore for a star performer on the scientific stage and we may profitably look in flashbacks at his career which made him and his Biology Division at Oak Ridge National Laboratory synonymous with innovative research.

In his personal research contributions, he may have come quite close to discovering that nucleic acids were the primary genetic material. Such a deduction would have been possible from the action spectra of UV wavelengths for inducing mutations. But as is known that not till the early 1950's was DNA accepted as the gene substance and this was so in spite of the earlier definitive finding of Oswald Avery and his co-workers that the transforming principle was DNA. Perhaps more than that, he was amongst the first to observe the phenomenology of cell recovery from radia-



Alexander Hollaender

tion damage which from the later elegant work of Richard Setlow and others turned out to be a manifestation of DNA repair. This latter aspect of DNA metabolism had not been presaged.

He organised and directed the Biology Division of Oak Ridge National Laboratory at Oak Ridge, Tennessee, which became a quasi-magnet even for the East Coast establishments. He enticed a number of brilliant scientists to the relative backwaters of Oak Ridge and in Bhabha-like fashion built research programmes around them. Whereas it might have been expected that his Division would concentrate on studies of biological effects of radiations, he broad-based the research programmes of the laboratory recognising very much ahead of others that genetics would play a key role in both basic and applied biology.

In order to attract visits of the senior talent, he conceived of organising the famed Oak Ridge Symposia at Gatlinburg, Tennessee in the Smoky Mountains. It is an interesting story how he decided to have the symposia at nearby Gatlinburg and not at Oak Ridge. Hollaender wanted to invite the great Caltech chemist, Linus Pauling, for his first symposium but realised that Linus, because of his pacifist activities, was considered a nuisance by the establishment and therefore may not have been cleared to come to Oak Ridge National Laboratory. He promptly moved the venue to Gatlinburg which as it turned out, provided a very much more relaxed atmosphere for discussing science.

Towards his retirement, he became interested in Environmental mutagenesis, carcinogenesis and teratogenesis and founded the American Society to foster research, training and [illegible] activities. He realised quite early that chemicals, because of their multitude and extensive use, are a bigger threat than radiations in this respect. His proselytising also brought in the Europeans who started the European Society, followed by the Japanese and finally the Indians, with K. Sundaram as the first President of the Environmental Mutagen Society of India. With Fred de Serres, Hollaender published another series of books on Chemical Mutagens which also continues to this day.

This profile of Alex would not be complete without saying a few words about his better half—Henrietta—who apart from providing him with the necessary emotional support may also have gotten him interested in art. Together, they have a legendary collection which includes works of Max Ernst, Jacob Epstein, Alexander Calder, Mark Rothko, Hans Hofmann and in particular those of CoBrA (Copenhagen, Brussels and Amsterdam) artists. When he was contemplating a move from Oak Ridge to Washington D C. and was looking for an apartment there, a friend jokingly suggested to him to sell his Rothko to buy the apartment. He became quite serious and told him that he had bought it for his personal pleasure.

So, what next after this marathon of activity? To mention a few; a symposium this year on "Plasmids" at Urbana, Illinois, in the US, "Low-dose effects" meeting at Brookhaven National Laboratory and yes, even a symposium on "Genetic engineering" in Calcutta in 1985. Hollaender's is not a passing show

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a cost of $3 2 million The 2.3-metre telescope has started functioning on Sliding Spring Mountain in the Warrumbungle Ranges near Coonabarabean.

What is unique is the telescope's manoeuvrability The building which houses it is cube-shaped and rotates 360 degrees. It is computer-controlled and can be operated from the Mount Stromlo Observatory in Canberra. The telescope will be used all the 24 hours as it will operate in infrared wavelengths during day time.

Breathe deep or die

SPORTSMEN engaged in stressful games like squash are vulnerable to sudden death. This was thought to be due to heart diseases they were not aware of or excessive strain on the player's heart due to lack of training. Allan Fowler of Bridgend Hospital, Wales, who studied 30 cases of squash players who died suddenly has another explanation.

He says during energetic exercises the body releases adrenaline which stimulates the heart to pump blood and oxygen at a faster rate. [illegible] the heart needs [illegible] sportsman does not take [illegible] the heart is starved [illegible] which could lead to a [illegible] death.

Call for an Association of Science Writers

INDIA has a big science establishment. The Science Policy Resolution adopted in 1958 by the Parliament enjoins us "... to participate fully in the march of science which is, probably mankind's greatest enterprise today". The objectives of science policy were explicit in the Resolution as raising the standards of living of our people, effective development of material and human resources, enhancing self-reliance, and ultimately, reducing the gap between the advanced countries and a backward country like India.

Last year we also adopted the Technology Policy Resolution. In the intervening period our national expenditure on science and technology (S&T) has constantly increased. We have created a very large scientifically trained manpower and are able to handle the more sophisticated technologies. We have comprehensive nuclear and space programmes, we go to Antartica and undertake deep sea mining and oil explorations. Our food production has more than kept pace with our population increase and new technologies are playing an important role in the defence of our country.

However, it is largely accepted that this scientific growth has not been able to deliver goods commensurate with its inputs. The rate of growth of our economy has been far lower than that of many other developing countries. More importantly, S&T have not helped the weaker sections of our society to the extent expected. On the contrary, the process of development seems to have actually increased the gap between the rich and the poor in our country, and added to the number of the impoverished and the destitute. The economic and technological gap between the more advanced countries and India has also widened.

There has also been a major deterioration of our environment in several sectors raising serious questions in some quarters about the wisdom of basing our development on unrestricted use of modern S&T Nor has there been a satisfactory progress in the development of a modern scientific outlook among our people.

Indeed, the vast majority of our people, even the literate ones, have never heard of our S&T policy resolutions, have no feeling for the method of science; many may even show an irrational hostility to the scientific ethos. Even those who do look up to science as some kind of panacea for all our problems, have little idea of what is going on in our laboratories, how our science policy is made, how our technological priorities are set, how scientific institutions are organised and what we can realistically expect from our S&T efforts.

Many discerning observers now feel, maybe with the advantage of hindsight, that one of the major lacunae in our entire S&T developmental effort has been this lack of informed participation and commitment on the part of a large section of our population. Now they feel that there is clearly a need for a more critical analysis of the past performance of our S&T infrastructure and a revision of our future priorities. In such a revision, a more vigorous participation of the people at large is of obvious importance, if the past mistakes are to be avoided.

Importance of popular science writing

For creating a mass awareness about the issues related to the use of S&T in national development, science journalists and writers have a crucial role to play. The importance and necessity of popular science writing to the overall process of modernisation cannot be overemphasised. Popular science writing includes writing about newer developments in different scientific and technological fields in a simple language for the benefit of non-specialists, and, the whole gamut of issues related to S&T like organisation and functioning of scientific institutions and production establishments using S&T, technical and financial decision-making in these institutions, problems of people who work in these establishments and their morale, interactions between science and society, decision-making at political levels, and interactions of local and national science with science at international levels and with politico-economic and military forces.

ONE of the many factors responsible for the failures of our S&T is the absence of an informed participation of our people. Popular science writing can greatly help in removing this lacuna

Some of the more important issues science writers have to examine and bring to the attention of people are:

To inform people about the latest developments in various areas of S&T in a language which non-specialists and lay people can understand. This will enhance the general level of awareness of the people about their environment and the major forces shaping this environment. The increased involvement in scientific issues will also indirectly help in inculcating a scientific temper and encourage rational thinking.

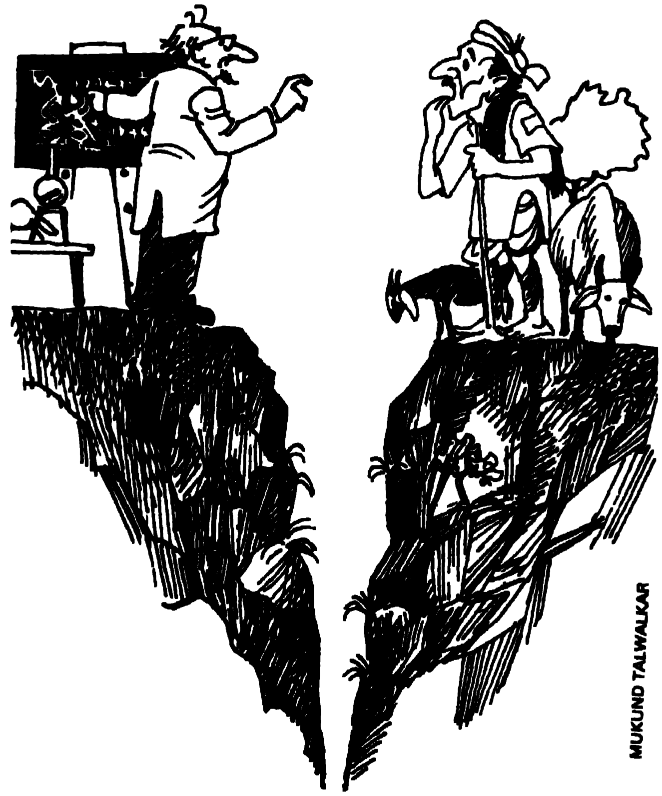
Providing a source of in-depth, independent information about important areas of science for the people and policy makers. Most of the policy decisions are taken by the political leadership and administrators who are advised by scientists. The latter, though most qualified to look into purely technical aspects of the issues involved, have their own limitations and often a vested interest in the development of specific areas. Hence they are not always in a position to give objective advice in the best interest of the people, who in the final analysis support all S&T and who have a right to expect maximum benefits from it. Under

such circumstances, availability of an independent source of information of the various aspects of the issues involved can be of considerable help to the decision-makers and to the people at large.

And presentation of latest developments in a simple, comprehensive style can also inform scientists about developments in other areas, where they may not have the necessary expertise, but where they may have to take decisions.

The importance of science writing is already recognised in the country. Most of the newspapers and popular magazines regularly devote some space to news related to S&T; several language publications can also boast of popular science writing. Major scientific meetings usually get good coverage. Science-related events like space flights, Antartica visits, test-tube babies, new cereal varieties, etc are all considerably played up. However, often the reporting is of a superficial nature. Much too frequently, official handouts given by different agencies and government departments are reproduced in toto, in the absence of professional science writers who could critically assess the information in the handouts. Such reports tend to give an exaggerated picture of our achievements and often portray S&T more as a source of (false) national pride than as an agent of socio-economic and cultural development.

On the other extreme, there are also instances of unsubstantiated criticisms of our entire scientific enterprise and of exhortations to reject modern S&T because it is considered mostly of western origin and hence not desirable for our society. One consequence of such reporting has been that S&T have become, to some, an object of



unwarranted pride and to others an object of mindless hostility. A realistic appreciation of the importance and limitations of science as an agent of socio-economic and cultural transformation and intellectual awakening has not yet developed.

Resolutions passed at the Science Writing Workshop

PII and IDRC, the organisers of the Science Writing Workshop held in New Delhi between 22 April and 3 May 1984 should:

1. Impress on the management of different newspapers to employ full-time science journalists on their staff.
2. Encourage science writers in the country to put up a co-ordinated front, especially when public interest issues are published in one section of the press.
3. Institute an award for science writing, in order to initiate more people into popular science writing and encourage excellence.
4. Work towards the formation of an Association for Science Writers.
5. Organise regular short-term courses for the benefit of science writers, to acquaint them with complex scientific topics, especially those of current interest and social relevance.
6. Work towards the evolution of a common scientific terminology for all Indian languages.
7. Encourage establishment of more popular science journals in different Indian languages and help their growth.

Formation of science writers' association

At a recent workshop, organised by the Press Institute of India and the International Developmental Research Centre of Canada at New Delhi "to enhance the skills of science journalists", these points, among many others, were discussed. The participants felt that these issues need a more serious examination by those involved in science writing for the mass media, including professional science journalists and scientists. It was also felt that the formation of an Association of Science Writers will be useful in examining these issues and initiating steps to improve the level of science reporting. Besides establishing better channels of communication among those interested in improving the standards of science writing in the country, such an Association also can act as a bridge between scientists and science policy makers and the people at large. It can also encourage professional excellence among science journalists and also look after their collective and material interests.

The detailed objectives of such an Association will have to be worked out collectively by its would-be members. Those who concur with the idea of forming such an Association and would like actively to participate in its formation and functioning are requested to get in touch with us with concrete suggestions.

B. S. Mahajan

PROPERTY OF 137

MULTIPLY any natural number by 137. In the result find the sum of the squares of the last two digits and the remaining number block. We find the added number to be a multiple of 137 (SCIENCE TODAY, September 1982, p. 33).

This can be generalised as follows: Split any multiple of the number into two digit blocks (in a way described later) and find the n power of the two digit blocks (n takes the value according to numbers and the way the products are split up). The resulting number is always an integral multiple of the original number

Any factor of $(10^{pq}+(-1)^p)$ including itself exhibits the above generalised property, say, G-137 Here p and q are integers, where q is the number of digits from right in the multiple or the point at which we split the product, say, SP—split point and p is the power to which the digit blocks are raised, say, I - index

Take 999999 which can be expressed as $(10^{3 \cdot 2}+(-1)^3)$ Any factor of it like 7, 13, 91, 999, 142857 etc exhibit G 137 property with SP=2 and I=3

For example, take 142857

$142857 \times 2 = 2857 \mid 14$

SP=2

$2857^3 + 14^3 (I=3) = 23320119537$

$= 142857 \times 163241$

Please note that the same number 999999 can be expressed as $(10^{1 \cdot 6}+(-1)^1)$. So the factors exhibit G-137 property with SP=6 and I=1.

$142857 \times 19 = 2 \mid 714283$

$2^1 + 714283^1 = 714285 = 5 \times 142857$

The numbers 37, 3, 9, 27, 111, 333, 999 are factors of $[10^{3 \cdot 1}+(-1)^3]$. So they exhibit G-137 property with I=3 and for any integral value of the split point.

For example, take 37

$37 \times 49 = 1813$

SP=1; $181^3 + 3^3 = 5929768 = 160264 \times 37$

SP=2, $18^3 + 13^3 = 8029 = 217 \times 37$

SP=3, $1^3 + 813^3 = 537367798$

$= 14523454 \times 37$

So far we have seen the index only taking odd values The readers can easily check the numbers 73, 137 and 10001 exhibiting G-137 property with indices 2, 4 and the corresponding split points 2 and 1 It is now very clear only odd numbers can exhibit G-137 property and that too, not all numbers. For example any number ending with 5 cannot exhibit G-137 property.

T. Gopinath

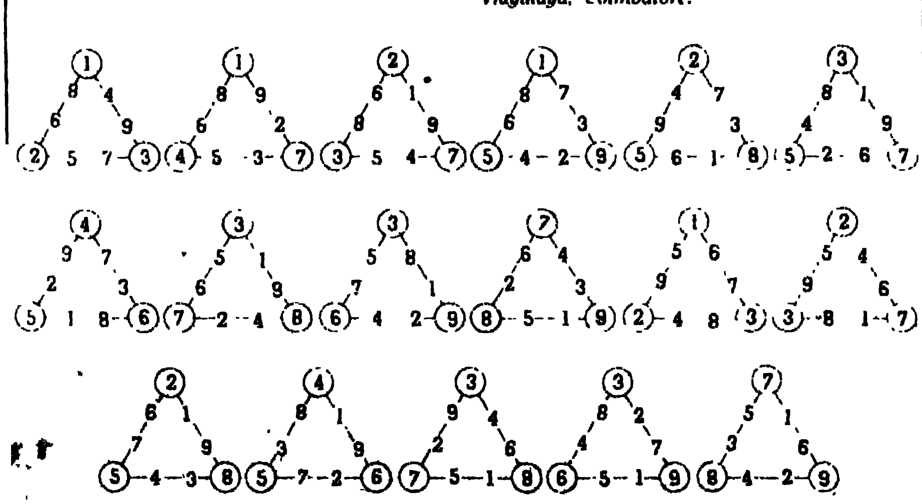
Mr Gopinath is with the Indian Institute of Science Bangalore

MAGIC TRIANGLES

USING numbers only between one and nine (both inclusive) we can form the following 17 magic triangles. The interchanging of two numbers on the same edge should be considered as one triangle.

Benny Kurian

Mr. Kurian is a student at the Kendriya Vidyalaya, Coimbatore.



488	512	524	460
520	464	484	516
468	532	504	480
508	476	472	528

A magic square for 1984

IT is composed of leap years only. Each row, column and major diagonal adds up to 1984 as do the four corner squares. The numbers used are from 460 to 488 and 504 to 528. Note that 492, 496 and 500 are omitted. As a matter of fact 492 and 500 add up to 992 which is half of 1984 and 496 is one fourth of 1984

Kishor N. Gordhandas

Mr Gordhandas is a mining engineer in Bombay

Curious identities

IT is not difficult to find a set of numbers the sum of which raised to the power 'n' will be equal to the sum of another set of numbers (containing same number of terms) raised to the power of n' Such a relationship holds good for value of n=1, 2 and 3 The following identities are given for 4 and 5 terms on each side where the sums are equal for any values of 'x' raised to the power of 'n' equal to 1, 2 and 3

Four terms on each side

$(x)^n + (x+4)^n + (x+7)^n + (x+11)^n = (x+1)^n + (x+2)^n + (x+9)^n + (x+10)^n$

Assume x = 12, therefore, $12^n + 16^n + 19^n + 23^n = 13^n + 14^n + 21^n + 22^n$, that is,

$12 + 16 + 19 + 23 = 13 + 14 + 21 + 22 = 70$

$12^2 + 16^2 + 19^2 + 23^2 = 13^2 + 14^2 + 21^2 + 22^2 = 1290$

$12^3 + 16^3 + 19^3 + 23^3 = 13^3 + 14^3 + 21^3 + 22^3 = 24850$

Five terms

$(x)^n + (x+3)^n + (x+11)^n + (x+12)^n + (x+19)^n = (x+1)^n + (x+2)^n + (x+9)^n + (x+15)^n + (x+18)^n$

Assume x = 23, therefore,

$23 + 26 + 34 + 35 + 42 = 24 + 25 + 32 + 38 + 41 = 160$

$23^2 + 26^2 + 34^2 + 35^2 + 42^2 = 24^2 + 25^2 + 32^2 + 38^2 + 41^2 = 5350$

$23^3 + 26^3 + 34^3 + 35^3 + 42^3 = 24^3 + 25^3 + 32^3 + 38^3 + 41^3 = 186010$

These identities can be extended upto ten or more terms on either side by appropriate combination of numbers on each side

D. S. Desai

Mr Desai is a consulting engineer in Calcutta

GLITTERING METAL FLOWERS

Desmond Avery

ONLY dedicated followers of science fiction used to take this kind of talk seriously a few years ago. Now businessmen and bureaucrats take notes.

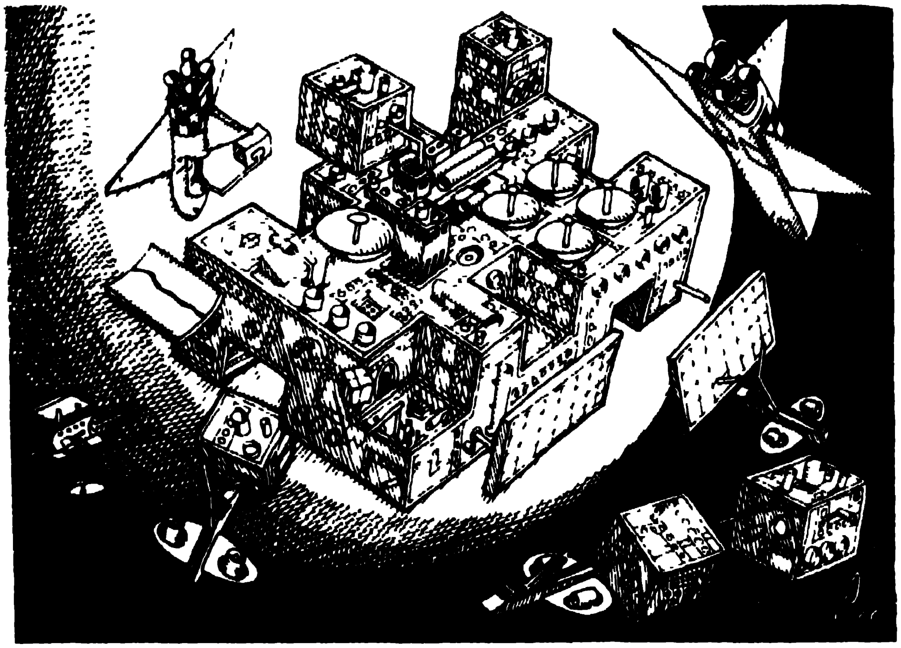
Comsats (communication satellites) as large as tennis courts can just be squeezed into existing launch vehicles, to unfold like glittering metal flowers when they reach space. But in another decade we shall need satellites as big as football fields—ultimately as large as cities (indeed, some of them will be cities!) They will become possible thanks to manned transportation systems like the Space Shuttle, which can carry construction crews and their equipment into orbit.

But why do we need such huge satellties—what have they got to do with the problems of the Third World? The answer may seem paradoxical, even perverse.

The speaker is Arthur Clarke, 65, father of satellite technology, author of 2001—and 2010—winner of the 1982 Marconi Award. As a member of the Sri Lankan delegation (he is still British but has lived for many years in Sri Lanka), he is addressing the first session of the Intergovernmental Council of the International Programme for the Development of Communication (IPDC), held in Paris in June 1981. His theme: New Communication Technologies and the Developing World. While developing countries are exploring possibilities of using new technology to solve their basic problems, it demands a high degree of professional training and competence to make use of these new artefacts. They have to be developed in the context of the region's "felt needs" Also third world cadres who could use this equipment have to be trained

This will also be the programme for training and research at the Sri Lanka Centre in honour of Arthur C Clarke for the study of communication, energy and space technologies, proposed by the Government of Sri Lanka and approved for support by the IPDC

Dr. Clarke is contributing $20,000 he received to the project He was cited "for first specifying in detail the potentialities and technical requirements for the use of geostationary satellites of global communications; for other innovations in communications and remote sensing from space throughout a lifetime of promoting the benevolent use of advanced space technology". The IPDC is contributing $40,000 from its special account. Moratuwa University, looking out over the Indian Ocean has provided the site and the Sri Lanka Government is sponsoring this project. The overall cost of establishing the project over the next four years is estimated at $4 million, and discussions on other forms of international co-operation are in progress.



Why such a thrust for ultra-modernity in a tranquil spot like Sri Lanka? Because, as Clarke sees it, in highly developed regions like the US and much of Europe, communication satellites are a great convenience, but are not absolutely vital. These countries already have excellent cable and microwave links.

To many developing countries, however, satellites are essential, they will make it unnecessary to build the elaborate and expensive ground systems required in the past Indeed, to such countries, satellites could be a matter of life and death To put it as dramatically as possible, unless major investments are made in space, millions are going to die, or eke out brief and miserable lives And most of those millions will be in the Third World.

Let me explain this paradox, which is typical of the way in which technology affects modern society—and is why no one without some understanding of these matters should be allowed to enter the corridors of power

Because the first comsats were small and feeble, it was necessary to build huge, multimillion dollar ground stations, with dishes thirty metres across, to contact them. Thus their sole use was to provide links between national telephone, telex and TV networks—where these existed. They transformed the pattern of world communications, but did not directly affect the man in the street—still less the man in the mud hut.

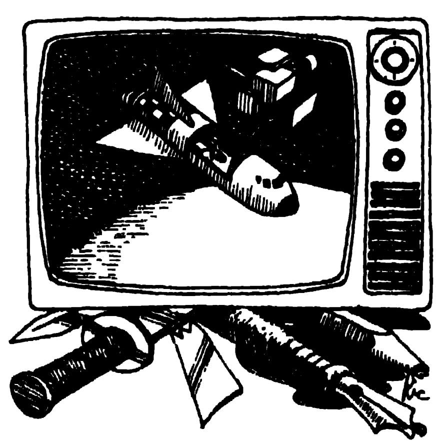
That situation is changing with explosive speed. When only a few score earth stations were involved it made sense—indeed there was no alternative in the 1960's and 1970's—to put the complexity and expense on the ground. But now that there are larger and more powerful satellites in orbit, ground stations can be much smaller and cheaper Indeed, for the simplest ones the cost has been reduced a thousandfold! All over the US there are now homes with dishes about three metres across picking up scores of programmes from the communications satellites hovering

high in the sky. Soon these dishes will be less than a metre across, and everyone who can afford a TV will have them. This is the beginning of the DBS—Direct Broadcast Satellite—revolution. It means ultimately a few very large satellites can provide any type of service—telephone, television, data, computing facilities—at extremely low per capita cost to every member of the human race... except for those rather few people who live near the North or South Poles...

Will this not just open the floodgates to consumerism and propaganda, drowning cultures and wrecking traditions? Clarke acknowledges that we frequently suffer from the scourge of information pollution, but draws attention to "its even deadlier opposite—information starvation". In the latter situation one is defenceless against all forms of tyranny—economic, social, political or cultural. "The cathode ray tube is a window on the world—indeed on many worlds," Clarke argues: the pen is mightier than the sword and the camera is mightier than both of them. The fact that the electronic media can be misused does not mean that they should be prohibited—"unless we assume that the invention of speech was a big mistake in the first place". Has not the greatest weapon in the struggle for human rights always been to communicate and publicise, by whatever media possible?

A valuable resource

At all events, there is a high level of conviction in many developing nations about the need for research and training in advanced telecommunication technology. Moratuwa already has a Department of Electronic and Telecommunication Engineering and is not far from the satellite earth station at Padukka. It is equipped for teaching microwave and radiation engineering, as well as hardware and software aspects of modern communication technologies. Another valuable resource of the university is the mind of Clarke himself, who was appointed Chancellor of Moratuwa University by President Jayewardene of Sri Lanka in 1980.



There is already lively competition among young scientists of the Asia-Pacific region for a place at Moratuwa, and it is likely to become worldwide as the new centre develops.

The project is planned in three phases. The first is in progress now and involves acquiring some crucial equipment, such as test instruments for energy research, microprocessors and components for an experimental satellite earth station. During this phase the groundwork is being laid for collaboration between the new centre and established institutions specialised in these fields abroad. Phase II will begin with a pilot programme of research and teaching at Moratuwa University, focussing on the curriculum and research methods that will be used in the new centre. Phase III, scheduled for 1985 will start with the construction of the facility of the Clarke Centre and develop its programme, its faculty and the co-ordination of its work with that of other institutions around the world.

The long term objective of this project as stated by the Government of Sri Lanka is "to enable the people of the developing countries to accelerate the process of development and participate fully in the new world order of information and communication." Manpower training for communications is an urgent need in the developing world. The Clarke Centre [illegible] be a pioneer in [illegible]

[illegible]

Save your neck from

Cervical Spondylitis

HELLO Soman, what is the problem? You look miserable

Doctor, I have this severe neck pain since morning and a slight pain in the neck for the last fortnight But it is fleeting in nature. Today, I cannot even move my head I am also getting a shooting pain in my right shoulder, arm and forearm on the right side The pain is horrible and I feel like crying

Now calm down First tell me if you have had any similar type of pains in the neck before

Yes, about six months ago I had a similar type of pain when there was extra work in my office I used to sit for eight to ten hours continuously writing reports and completing the entire year's audit. At that time, I had applied some balm and taken Novalgin tablets and the pain disappeared in a short time.

What happened this time?

This time the severity of pain is greater

Are you doing any exercises?

Yes I do Shirsasana *(legs up -- head down) regularly and I have been at it for the last ten years*

One thing you must remember is that after the age of 40 you must not do *Shirsasana* It hastens cervical spondylitis as the entire body weight has to be borne by the head and neck bones. *Shirsasana* also causes high blood pressure

Why does cervical spondylitis occur after 40 years of age?

The cervical vertebrae (neck bones) are controlled by powerful neck and shoulder muscles In youth when the muscles are powerful 85 to 90 per cent of the strain occurring in the neck region is borne by them and the rest of the strain is borne by cervical bones But as you grow old these muscles are exercised less and more strain is put on the cervical vertebrae This extra strain caused by extra work may hasten the process of spondylitis of the neck bones

Actually what is this spondylitis?

Spondylitis is an inflammation (swelling) occurring at the joints of the vertebrae This can happen either due to strain or injury or to degeneration of the bony tissue because of old age.

But why the pain and stiffness of neck?

In cervical vertebrae two segmental nerves pass through the intervertebral foramina (a tiny opening) and the spinal cord passes through the central canal Now, in early cases of acute cervical spondylitis, there is inflammation in the joints of the vertebrae And if the inflammation is not cured, the liquid state of inflammation gradually becomes solid state in a natural process. This solid state of inflammation is called adhesives which may press over segmental nerves giving rise to shooting pains

In chronic cervical spondylitis, calcium is deposited in adhesions giving rise to spur formation, that is, hard horn-like processes may impinge on nerve roots or on the spinal cord. This also gives rise to severe pain in the arm, shoulder, or superior extremity or may even lead to partial paralysis of the body.

So it's imperative that the neck and shoulder muscles are strong and well-toned.

Positively If your neck and shoulder muscles are powerful and you can avoid overstrain, like lifting heavy loads or even reading and writing for long hours, your chances of getting cervical spondylitis are rare.

Normally at your age (above 40 years), we must always exclude diabetes, septic focus, worms, etc. These disorders will eventually need corrective treatment and the X-ray will show to what level cervical spondylitis has progressed.

And, will I be cured soon after I begin the treatment?

Sure. But listen carefully. Take these (anti-inflammatory) medicines which will relieve your pain and swelling of your neck and apply ointments, like Relaxyl locally. You will need infra-red therapy applied in the neck and shoulder region to relax the muscles. And as you have indicated pain in the shoulder and arm regions too, you will also need a cervical traction. It helps in increasing the space in intervertebral formina and hence relieves pressure over the nerves. If the pain is severe and persistent

Neck exercises to strengthen neck muscles

Doctor, are there any other symptoms the patients present in cervical spondylitis?

Oh yes. There can be pain in the back of head (occipital headaches), giddiness occurring when the neck is held in a particular position, which disappears with a change in position of the neck, and pain in the left side of the chest, shoulder and arm This sort of pain is similar to the type experienced during a heart attack And, so first of all heart trouble has to be ruled out with an electrocardiograph (ECG), especially in old people

So, what would you advise me to do?

I am advising you to take the following tests an X-ray of the cervical spine, urine, stool and blood examinations and a check-up of blood sugar

Why do you want all these investigations performed?

you will need a cervical collar which will restrict your neck movements completely Once the pain is relieved, you will need neck-shoulder exercises which will be explained to you by a physiotherapist.

Will this treatment make me completely normal or will I have to undergo surgery eventually?

Surgery is needed only in those cases where there is no response to medical treatment or there is an increase in the weakness of the muscles of extremities But in your case you need not worry as you have come early

Doctor, a last question Have I to wear the cervical collar for a long time?

No, just for a few days or weeks, till the muscle spasms of the neck are relieved. The cervical collar acts like a support to your neck, just as a walking stick relieves painful knee joints

Cervical vertebrae showing normal spine (1) and stages of new bone formation (2 and 3). The latter characterise chronic spondylitis

How can one avoid cervical spondylitis?
It's quite simple. You only have to follow certain rules.

Do regular neck and shoulder exercises, avoid reading or writing for long hours or take breaks in between, avoid reading in bed and take normal care of health.

Doctor, can you give some details about the neck-shoulder exercises?

Yes, there are two sets of exercises which can be done for strengthening the neck and shoulder muscles. For flexion and extension exercises, stand at ease and look forward. Now try to touch your chin to chest and then bend your neck backwards, as far as possible. If you get pain, stop and do not over exert. Do the movements till you just get the pain. Gradually you will improve on it.

For the neck and shoulder exercises, sit on a stool and raise both shoulders upward and gradually lower them. Try to keep the neck straight during these movements. Once you have practised these movements 10 to 15 times and there is no pain ask someone to keep their palms on each shoulder and to put pressure on them. Then you do the same exercises against the pressure. Thus shoulder muscles will gradually improve in power.

Both these exercises you must do five times each, to start with, morning and evening. Gradually increase the movements to 10, 15, 20, 30 counts. You will have to do these exercises regularly and if you do not want to get a second attack of cervical spondylitis do them daily for life-time.

M. V. Kudtarkar

Dr. Kudtarkar, an orthopaedic surgeon was formerly attached to the Civil Hospital, Thane, Bombay

The IITs: reservation rigmarole

A SINISTER document which threatens to undermine standards of excellence of the IITs is the recent report of the 17-member Parliamentary Committee on Scheduled castes and Scheduled tribes. It alleges that these depressed classes were deliberately denied entry into these "centres of excellence" by making the Joint Entrance Examination (JEE) so tough as to render it more a means of elimination than selection.

As many as two-thirds of the 250 odd-seats earmarked for SCs/STs remain unfilled in the five IITs, at Bombay, Kharagpur, Delhi, Kanpur and Madras. Of the 250 or so seats reserved for them in 1981-82, only 55 were filled. In 1982-83, 50 were filled, and in 1983-84, 135 candidates qualified for admission.

The Committee has suggested a separate entrance examination for SC and ST students with papers set by people other than the IIT faculty. Indeed, on the Committee's recommendations, the Education Ministry has directed all the IITs to conduct a separate entrance examination for those SC/ST candidates who couldn't make it in the previous year in the JEE. These students, meanwhile, will be given a year's special coaching for it There is talk, too, of the Central Government introducing reservation for backward classes also in the IITs.

The first to protest against this legislative "depression of standards" was Dr. P. V Indiresan, Director, IIT Madras. He said: "More than the attack on the IIT system, the manner in which it was done is a matter of concern. The directors of all the five IITs were bullied, insulted and abused in unprintable language by some members of the Parliamentary Committee on Scheduled castes Even in the heyday of British imperialism, I doubt whether such things ever happened The really worrying part is that I have not been able to get any intellectual or administrator who is willing to stand up and be counted on to say that such things shouldn't happen. It is this total emasculation of the intellectual and professional that is the real cause for worry."

Raising a fundamental question, Dr. Indiresan asked: "Whether just because a group of people cannot cope with a certain level of education they should have the veto power to deny such an education to the rest; whether social justice should imply that there should be no institution at all in the country where merit shall be the criterion and also while the socially deprived should have special privileges; that the talented need have no rights of their own." Predictably, the IIT Chief incurred the Government's wrath for his outspoken utterances.

In the matter of reservations for SC and ST students in the IITs, a decision was taken in June 1983, to dilute the norms for admission to such a level that the full quota of seats for SC and ST candidates in the IITs can be filled. This was done against all canons of academic propriety.

The decision was taken by the Union Education Minister who overruled all objections of the council of the IITs. Accordingly, SC and ST students with less than 40 per cent marks in their school final examinations were admitted to the IITs as late as in September, although they would not normally have gained admission even to the B.A. course. Recommendation No. 3.29 of the Parliamentary Committee states that "the percentage of reserved seats in the IITs which remained unfilled during 1980-81, 1981-82 and 1982-83 were 39 per cent, 76 per cent and 80 per cent for SC students and 75 per cent, 96 per cent and 92 per cent respectively for ST".

The Parliamentary Committee **vetoed a suggestion to improve the standard of SC and ST students. And it rejected a scheme of the Education Ministry about to be implemented, under which SC and ST students at the plus two stage were to be provided free residential coaching. The Parliamentary Committee felt "that the introduction of the residential free coaching scheme will be time-consuming and may not improve the intake of SC and ST students (in the IITs immediately). As such, the committee recommends that meritorious SC and ST students should be admitted in IITs and they should be given special coaching".**

The suggestion that SC and ST students be selected and trained right from the kindergarten level was also guillotined. IIT professors fear that forced and contrived admission of academically poor SC/ST students will lead to a backlash from the other communities.

Despite reservation of seats that provides them entry into the IITs with relative ease, most SC/ST candidates are unable to cope with their studies. Some MPs have gone so far as to say that what we need is an "Indian standard" and not an international standard of instruction for science and technology

Says Prof. Indiresan: "It is quite clear that the concession given by IITs for the admission of SC/ST students is more than that given by the other professional colleges in the States. In spite of this relaxed standard, sufficient number of SC/ST students are not getting qualified. This might be due to the feeling among these students that the courses in IITs are quite rigorous compared to that in State Colleges. Moreover, most of the graduates get employment in Public Sector Undertakings against reserved quota without much competition So it does not matter from where they take their degrees. Hence these students prefer to pursue their studies in State Colleges."

It is not as if the IITs have taken no measures to improve the lot of the SCs/STs. Says Dr. Indiresan: "Not content with what we have been doing for SC/ST students over the years, we have initiated a number of programmes for the last four years. In 1981, 1982 and 1983, about 150 students from the four Southern States were invited to an 'Introduction to IIT Programme', during which the students were taken round the various departments and they were told about the facilities given to them. In April 1982, these students were given a two weeks Personal Coaching Programme prior to JEE to equip them better for JEE. Still the results were not satisfactory.

"So, we started a one year Correspondence-cum-Personal Coaching Programme. About 162 plus-two students from the four Southern States were invited for the first Personal Coaching in June 1983. Postal lessons in English, Mathematics, Physics and Chemistry were being sent now. Based on the lessons sent, there was a one week Personal Coaching in December 1983. Further, lessons were sent between January 1984 to April 1984, followed by two weeks Personal Coaching Programme in April-May 1984. In fact, these students will be writing the JEE 1984, staying in IIT Madras itself. For the entire Programme, to and fro train, boarding and lodging charges, course fees, etc, are fully met by IIT Madras.

"Another parallel Programme was started on 24 October, 1983 for candidates who failed the JEE in 1983. They were given one year training in English Mathematics, Physics and Chemistry covering the syllabus of 11th and 12th standard. Based on their performance they would be admitted to the B.Tech Programme."

Dr A. K. De, the Director of IIT, Bombay, and Chairman, Atomic Energy Regulatory Board, says: "As of now, 22.5 per cent seats (15 per cent for SC and 7.5 per cent for ST) are reserved for admission to this historically suppressed section of the Indian people. The reservation pressure came from the Centre in 1973, when all the SC/ST students seeking entry through the JEE were admitted, irrespective of their performance in the competitive entrance examination. This continued till 1975. The result of this experiment was disastrous. Very few SC/ST students passed in spite of one extra year of preparatory course, extra coaching and other concessions and incentives. Since 1975, the mode of admission was changed to ensure that an arbitrary admission policy was not followed. The directors agreed to a relaxation, and it was decided that SC/ST students should be admitted up to two-thirds of the cut-off point, the percentage in the JEE obtained by the lowest in the merit list."

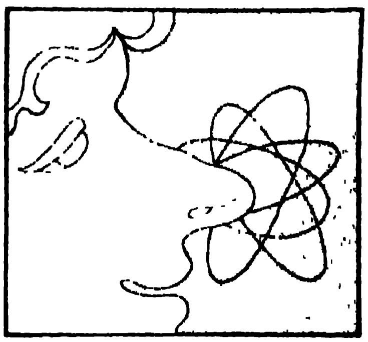
Thus, if the last ranking candidate in the list of about 1,800 got 60 per cent of the total marks, the SC/ST student getting even 40 per cent would be eligible for admission. Moreover, since 1982, a SC/ST candidate is no longer required to pass in individual subjects. However, a SC/ST student failing to secure even the specified qualifying aggregate in the JEE cannot be admitted. This procedure has been fairly successful. But, according to Dr. De, very few SC/ST candidates succeed just because the number of those taking JEE examination itself is much less. He insists that: "Equality is all right but quality is a must, not might. We shouldn't mix up the two issues. The quest for excellence presupposes high standard of the JEE. The exam will have to be tough if we are to meet international standards of academic excellence. We do want SC/ST students, too, to excel in competitive spirit. However, forcing the pace by taking pseudo-compassionate attitude will prove counter-productive We must inculcate the competitive competence and imparting the quality education from the beginning—at the school stage itself. 'Catch them young' should be our motto and credo if we sincerely have the welfare of this historically disadvantaged section of society at heart. Wider publicity of the JEE and early identification of talented and potentially motivated SC/ST students in schools for intensive coaching by the Government are imperative, nay, inevitable."

Says Prof. Hiralal, a senior Professor of Chemistry, at IIT Bombay and an eminent academician, who was Chairman, Admission Committee, JEE in 1983: "Watering down the standards of admission for SC/ST students would be a positive disservice to them. As it is, the JEE exam has had a certain sanctity with no scope for escape. The answer-books of even SC/ST candidates are evaluated alongwith the rest and marked without the examiner knowing whether the candidate belonged to SC/ST or not. Even with relaxation (2/3rd cut-off) the system has been working reasonably well and the students have been no source of intense agony or pain to us. The crux of the matter is that more applications must come to ensure more admissions. At present 2½ per cent of those who apply have a chance to make it, be they from unreserved category or SC/ST. Extraneous considerations, how relevant or justified, have no place whatsoever. I have even grave doubts about the latest experiment in latitude and leniency—preparatory course for SC/ST candidates. The Commissioner for SC/ST should see to it that special coaching is given to suitably identified brighter boys and girls in the secondary schools for further training "

In the ultimate analysis, if enough SC and ST students are not available today to fill their quota of seats in the IITs, they can be produced a decade hence by imparting them sound education right from school. One can't ameliorate the lot of these disadvantaged sections by merely filling up the 22.5 per cent quota of seats and devaluing IIT education Has anyone heard of reservation in the crucial departments like Atomic Energy and Space as also in the Armed Forces? The heart of the problem is: how long will this policy of reservation and reverse discrimination continue to play havoc with standards?

D. K. Dixit

Mr Dixit is a mechanical engineer doing his Ph.D. at IIT, Bombay, on deputation from Visvesvaraya Regional College of Engg., Nagpur.



OF NOSES AND NUCLEAR RESEARCH

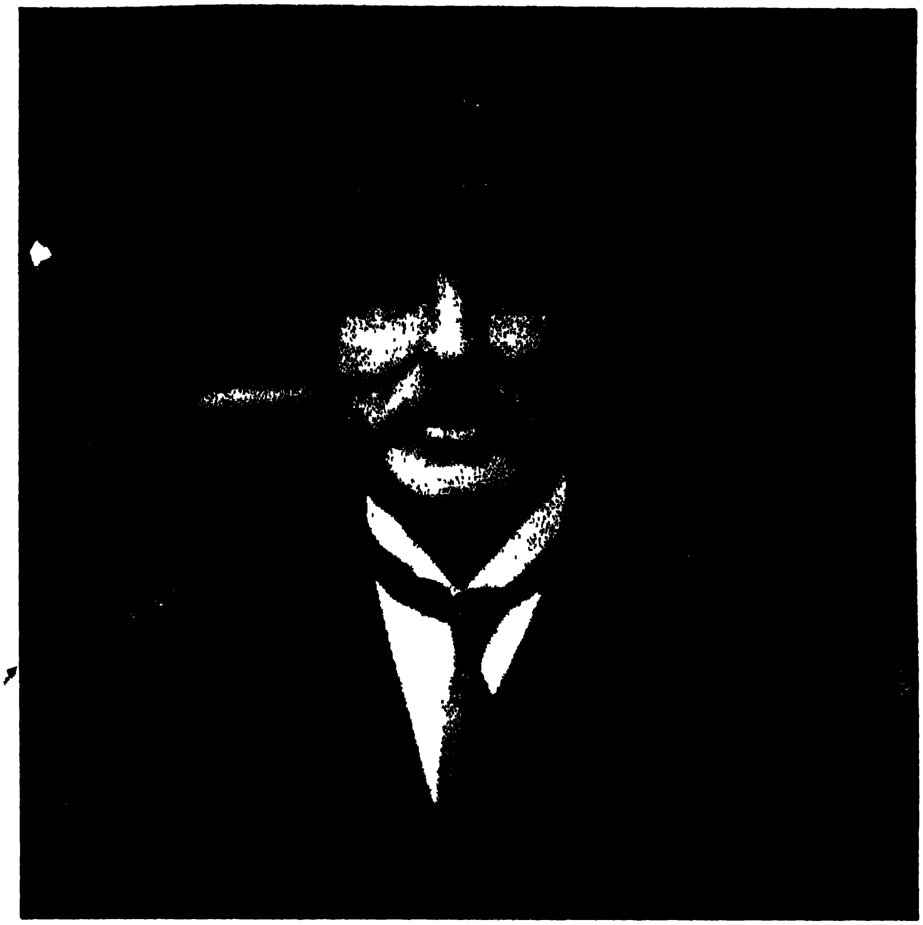
THE human nose has always exercised a great fascination upon mankind Pascal it was, who put it epigramatically, "Had Cleopatra's nose been shorter, the whole face of the earth would have been different." No doubt, that face of Helen of Troy which "launched a thousand ships" had an attractive nose adorning and enhancing her bewitching beauty

The shape and the size of the nose make or mar a face. Persons with long and shapely noses are believed to be the possessors of good intellect Indeed, Napoleon, whenever he had some ticklish problem to be solved, was particular of entrusting this to his officers with long nose William Hazlitt while admiring the socratic brow of his friend S T Coleridge remarked his nose "the index of the will was small, feeble, nothing" Another famous friend of his, Thomas Carlyle wrote to his brother in 1824, "I have seen many curiosities not the least of them I reckon Coleridge Figure a fat, flabby personage, at once short, rotund and relaxed, with watery mouth, a snuffy nose, a pair of strange brown timid yet earnest looking eyes He is a kind soul, full of religion, affection and poetry and animal magnetism His cardinal sin is he lacks will He has no resolution ' No man of letters in England planned so much and achieved so little as Coleridge In contrast to Coleridge, Lord Byron possessed an excellently shaped nose enhancing his romantic appearance considerably It is not surprising, therefore, that the youthful lady Caroline Lamb, wife of Lord Melbourne, the future Prime Minister of England lost her balance and judgement and chased Byron in a boy's apparel Another famous English man of letters W M. Thackeray, while at School at Charter House had pugilistic propensities like young Walter Scott and Byron, and as a result got a broken nose which could not be repaired. So he suffered considerable discomfiture throughout his life while moving in social circles Nose has always attracted the attention of poets. Tennyson admired a "slender nose tip tilted like a petal of a flower". The classical nose of Falstaff became sharp as a pen at his death. The boozer's red nose has been commemorated by the following lines·

Nose, nose, jolly red nose,
And who gave thee this jolly red nose,
Nutmegs and ginger, cinnamon and cloves,
And they gave me this jolly red nose

Kaptiza at the Nobel awards ceremony

During the second and third decades of this century a galaxy of scientists—James Chadwick, P. M. S. Blackett, F. W. Aston, C. T. R. Wilson, E T. S. Walton, Arthur Eddington, John Cockcroft, Mark Oliphant, Pyotr Kapitza, to name a prominent few—were working under Professor Rutherford in the world famous Cavendish Laboratory in Cambridge University. Like Dr. Johnson of literary world, Lord Rutherford dominated the scientific world of his time. In the midst of serious nuclear research activities in Cavendish Laboratory, a raging controversy arose in 1933 on the shape of the nose of a profile of Lord Rutherford. It was not a light-hearted banter to give relief to them from the serious nuclear fission studies they were engaged in To them this matter of the nose was as serious as their experiments in atomic research. Pyotr Kapitza, a young Russian Engineer, who had suffered a lot in the Russian Revolution and had lost his first wife had joined the Cavendish Group of Scientists early in 1922 was the storm centre of the controversy This eminent engineer who had been doing experimental work of great importance on strong magnetic fields since 1922, became the Royal Society Professor in 1932 The Royal Society gave a grant for building and equipping a suitable Laboratory for Magnetic Research out of the bequest of £50,000 to the Society by the great Industrial Chemist, Dr. Ludwig Mond. The Laboratory was designed by Pyotr Kapitza with the able assistance of John Cockroft and the eminent Architect H. G. Hughes Named Royal Society Mond Laboratory, it was opened in February 1933 To honour his professor who was a great inspirer of research activity, and whom each and everyone in the Cavendish Laboratory held in great reverential respect, Pyotr Kapitza decided to have a plaque of Rutherford profile curved for adorning the entrance hall of the Laboratory Eric Gill, the renowned sculptor of the School of Modern Art next only to Epstein in name and standing in the profession, was entrusted with the work. The job was executed in great secrecy behind tarpaulin cover by the sculptor But when it was exposed to the public with the inauguration of the Laboratory, entire Cavendish Laboratory was rocked by a storm of serious controversy over the shape of the nose in the sculpture. The nose in the profile had a prominent bridge and to some it looked like a Jewish nose. But the sculptor differed and was of the opinion that the striking feature of the Jewish nose was not its bridge but its beak. His firm view was that the profile nose



Rutherford,whose nose started it all!

was Roman in appearance but not definitely Jewish. The sculptor recalled the complaint of Lorenzo de Medici over Michaelangelo's portrait of him, saying that it was not his likeness, which brought forth the famous reply of Michaelangelo saying "it will be like you, in a hundred years time".

Pyotr Kapitza greatly upset by the lack of appreciation tried his level best to assuage the feelings of his colleagues. He gave lectures on Modern Art. But all to no account. Senior scientists led by the conservative Aston took objection to the shape of the nose and wanted it to be modified or the sculpture removed. The youngsters were in a more rebellious mood. They vowed to smash the profile to pieces during the night. The B.B.C. too did not miss this opportunity in its broadcasts and gave widespread publicity to the controversy.

Lord Rutherford was considerably embarrassed. He could not support either side. He would not sit in judgement. He confessed that he was no judge of fine arts. While Lady Rutherford was a fine performer on piano and was an ardent lover of classical music, he had no ear for the music either. He was no doubt a voracious reader of novels, biographies and history. He was too much obsessed by his physical experiments in nuclear fission and had practically no other absorbing interest in life. In this, he was like a man possessed. But he knew that the famous theoretical physicist and the head of the University Institute of Theoretical Physics in Copenhagen, Niels Bohr who had worked with him during his Manchester days and who was a frequent visitor from Denmark to Cavendish Laboratory, was a good judge of modern art. And Niels Bohr had the advantage of being away from the scene of this unseemly ~~controversy~~ controversy. Could Kapitza write to him and get his decision on the matter? This was Lord Rutherford's suggestion.

Pyotr Kapitza wrote to Professor Niels Bohr early in March 1933 giving a complete picture of the controversy and seeking his decision in the matter. He had enclosed a good photograph of the carved profile and had specifically mentioned that he was writing to him on Rutherford's instructions. Niels Bohr promptly wrote back that despite the difficulty in judging a piece of sculpture from a photograph, the carving looked to him "most excellent being at the same time thoughtful and powerful" and that therefore he "could not in any way support the critics of the carving". So this judgement coming as it did from so eminent and impartial a person as Niels Bohr who held Lord Rutherford in great love and reverence had a sobering effect on the Cavendish critics. And within a year the controversy gradually died down with no damage done to carving or its disputed nose. A thankful Pyotr Kapitza who had an agonising time from the date of inauguration of the Royal Society Mond Laboratory, got an exact replica of the profile made by the same sculptor and presented it to Niels Bohr who very warmly accepted and proudly displayed it in Copenhagen Institute.

Poor Pyotr Kapitza! His troubles were not over yet. Since 1926 he had been visiting Soviet Russia. In 1934, he again went there to attend the Conference held in honour of the great Russian chemist Mendeleeff. A shock was in store for him this time. As he was preparing to leave for Cambridge, the Russian authorities told him that his presence was needed for the advancement of Science in Russia and that he should, therefore, work there. He was greatly distressed by this unexpected development so soon after he had taken so much trouble to bring Mond Laboratory into existence. So also were his distinguished colleagues in Cavendish Laboratory. Lord Rutherford wrote to Prime Minister Stanley Baldwin to intercede in the matter. He himself wrote to the authorities in Moscow. Pat came the reply "If Kapitza was required for England, Lord Rutherford was required for Russia. Could this be arranged?" Initially Academician Kapitza was seriously handicapped in his work in Russia since all the equipment he had so carefully assembled was in England. Eventually when Russian Government bought the apparatus from U.K. for £30,000, these were transferred to the Institute of Physical Problems in Moscow which Kapitza was ably directing since its inception.

S. R. Balasubramanian

Mr Balasubramanian is a free-lance science writer from Pune

A FROSTY RECEPTION TO A SPORTY BUG

"A COUPLE of inches of dead bacteria and water can make a skier's day". This idea may not be far-fetched if the highly controversial and publicised "frost bug" is soon commercially exploited

Frost injury is a major agricultural problem affecting various important crops like maize, apple, tomato and citrus. Frost damage is brought about by formation of ice in the various parts of a plant and is initiated by "ice nucleation" (Ice nuclei are particles that initiate the freezing of water). Earlier it had been demonstrated that various inorganic minerals and types of soils like clay, and organic matter like decaying leaves, could serve as a source of the ice nuclei. Recent findings reveal that certain bacteria of *Pseudomonas* and *Erwinia* species can also act as sources of biogenic ice nuclei. These bacteria have come to be popularly known as "frost bugs".

The above mentioned two species are epiphytes distributed widely. They limit the supercooling of water in the plant by initiating the formation of ice at temperatures between $-2°C$ and $4°C$. Experiments have shown that ice does not form on plants free from the ice-nucleation bacteria, even at temperatures below $-10°C$ Following the damage of plant tissue by freezing and thawing, bacterial entry through the tissue destroys the plant or tissue The cause of ice nucleation by these bacteria has been found to be due to a protein. The genes that code for this protein (termed INA gene) in these two frost bugs have been isolated, cloned and expressed in *E. coli.*

Two strategies have been proposed recently for the biological control of these bacteria: Use of predator - bacteriophages and use of competitor - INA strains. The former strategy has the disadvantage that it could lead to the selection of "phage-resistant mutants" of the bug, which could affect its future control. The latter strategy involves the use of INA-(ice minus) strains where the ice-nucleation gene has been deleted. These act as antagonistic bacteria which compete with their wild-type counterparts and, eventually, displace them by occupying the same physical space and utilising the same nutrients

A controversy started when the Recombinant DNA Advisory Committee of the National Institutes of Health, USA, granted permission to Drs. Nikolas Panopoulos and Steven Lindow of the University of California, Berkeley, to field-test the "ice minus" frost bugs The case catapulted to fame, as the experiment would have been the first deliberate release of a genetically engineered microbe into the environment. This was almost immediately followed by an uproar and a string of law suits by powerful lobbies of environmental groups. The latter claimed that the releasing of recombinant DNA mutants could have severely damaging consequences for the environment. Apart from the unpredictability of the pathogenicity, host-range, virulence and survivability of the strains, a major concern was expressed that the frost-resistant bacteria might enter the atmosphere inhibiting natural formation of ice and the precipitation processes. This would affect global rainfall patterns and climatic conditions.

The counter arguments by the Berkeley group were that these fears were unfounded. The chemically mutated INA-strains had already been field-tested. The genetically engineered organisms were considered safer and more advantageous than the chemically mutated ones as in the former specific deletions not altering neighbouring genes could be expressed, unlike in the latter The microbes used they argued, were not pathogenic to humans and were almost ubiquitous and omnipresent plant epiphytes. The impact on the rainfall patterns was thought to be extremely small or non-existent, as the potential reduction of atmospheric ice nuclei would be negligible; this is borne out by the absence of such effects following the use of agro-bactericides during the last four decades.

The novelty in the idea, apart from the media publicity and the raging legal battle, is that the frost bugs may have a considerable biotechnological potential. The chief utility would be in protecting tender seedlings from spring frosts that cause an average annual loss in the US alone of one to three billion dollars or more. Another attractive potential would be the use of wild-type *P. syringae* as ice nucleators for snow-making. The snow produced by the freeze-dried bacteria in a mechanical system could find use in air-conditioning and in winter sports like skiing. The ice-nucleation protein could be used for seeding clouds, thus alleviating the effects of severe weather conditions and increasing precipitation in arid regions.

While the debate continues, it is to be seen when the legal and regulatory hurdles would be overcome. The day may not then be too far when a biotech firm comes out with a formula for an "instant ice cream"!

R. Gururajan
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New artificial sweetener

A SWEETENER may be defined as an AH-B system made up of a proton donor and a proton acceptor in which both groups are roughly 3×10^{-8} cm (3Å) apart with a lipophilic binding site. This system is supposed to interact with the membrane sweet taste receptor cells which are considered lipophilic.

The most commonly used artificial sweetener, Saccharin, is about 550 times sweeter than sucrose, but it has the unpleasant after-taste Cyclamates were also used as sweeteners. But the belief that an association between cyclamates and bladder cancer led to a ban on the use of cyclamates as a sweetener in the USA and other countries. This situation led to a race to produce new varieties of sweeteners which were non-fattening, would not cause tooth decay and could be used safely by diabetics— in an attempt to replace sucrose.

The Food Additives and Contaminants Committee of Britain permitted in 1982 the use of the artificial sweetener Acesulfame K, a product introduced by Hoechst after 20 years of research, in food and drink. Acesulfame was an accidental discovery, as were, indeed, all the other sweeteners. A sweet taste was noticed while investigating compounds made by reacting butyne with fluorosulphonyl isocyanate—the sweet taste was attributed to the formation of 5,6-dimethyldihydrooxathiazinone-dioxide with a hitherto unknown ring system, a six-member heterocyclic in which the oxygen, sulphur and nitrogen atoms are adjacent to one another. By carrying out intensive investigations, it has been concluded that 6-methyl-1,2,3-oxathiazin 4 (3H)-one-2,2-dioxide, Acesulfame K, was judged to be the best sweetener *(Chemistry and Industry* **427**, 1983).

This new sweetener is synthesised from acetoacetic acid tert-butyl ester and fluorosulphonyl isocyanate. The two compounds readily react to form an addition compound which decomposes on heating to give an amide. This amide in the presence of potassium hydroxide yields Acesulfame K. Metabolic studies with several animal spe-

cies and human volunteers demonstrated that the kinetic properties of the new sweetener are similar in animals and humans. No accumulation of this sweetener is possible as it is absorbed quickly from the intestine (detectable levels in blood and serum rise quickly) with a fast excretion. Its stability and inertness may not pose a problem to the environment on its disposal, as investigations with several species of fish revealed the fish-toxicity of Acesulfame K to be low. Oral toxicity studies indicate it to be virtually non-toxic. Long-term feeding studies for detecting potential carcinogenic effects reveal that it is not likely to be associated with cancer.

Acesulfame K is a white crystalline solid which is only 200 times as sweet as sucrose. Because of the aforesaid advantages, it can be used in a variety of foods, and hot and cold drinks and may be combined with natural bulk sweetening agents, such as sorbitol, to give a flavour distinguishable from sucrose.

C. Srinivasan

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A close watch on Earth

ILLUSTRATED BY DHANANJAY

Scientists are studying ways of conducting VLBI from space with collapsible radio antennae carried aboard space shuttle

PLANET Earth, a distinguished member of the solar family, came under close scrutiny during 1980 to 1983, when its rotation was carefully monitored in three fundamentally different ways by sophisticated space-age instruments. As we are well aware, the Earth's rotation around its own axis gives rise to days and nights. A tilt in the axis causes different seasons.

For centuries, the rotation of the Earth has been monitored for measuring time. The total time of a day plus night is more or less a constant (length of day) and this period of 24 hours is devided into minutes and seconds. As clocks became more and more accurate, it became clear that the length of day is not a constant. Even the early pendulum clocks had hinted at it but clocks stabilised with quartz crystals confirmed it. Time-keeping, today, is relegated to atomic clocks which are so precise that they run for thousands of years without losing or gaining a single second.

Though the Earth's rotation has ceased to be a unit of time, its variations, however, are studied as they have applications in geodetic surveying, navigation and astrometry. It also aids basic research in the dynamics of the Earth. With this in view, a study was undertaken by a team of scientists in USA to monitor Earth's rotation accurately over a period of three years—from October 1980 to September 1983. The three sets of sophisticated experiments carried out were essentially dissimilar, based on totally different concepts.

One set of experiments was based on satellite laser ranging (SLR). An artificial satellite whose orbit is precisely known, is used to reflect a beam of light sent by a laser on Earth. The time taken for the beam to make a return trip is used for ranging the satellite precisely. The Laser Geodynamic Satellite (LAGEOS) was launched in 1976 to enable such studies requiring high orbital stability. It is a solid sphere 60 cm in diameter, its surface covered with 426 retroreflectors. It is interesting to recall that the same satellite revealed earlier that the Earth is pear-shaped. By tracking LAGEOS with short laser pulses emitted in quick succession, variations in Earth's rotation were measured.

The second technique used was very large base-lined interferometry (VLBI), using instrumentation and software specially designed for space applications. An array of radio telescopes is used to collect faint radio signals from sources such as quasars. The signals are simultaneously recorded on magnetic tapes and the tapes are transported to a central facility to cross-correlate the data. Two types of information are extracted from this: the celestial coordinates of the sources and the relative distances between the sources (vector baselines). Variations in the length of day can be deduced from this.

The third technique measured the Earth's rotation from the observed changes in the angular momentum of the atmosphere (AMA) Global summaries of the state of the atmosphere are issued routinely by The National Meteriological Center of USA. Atmospheric angular momentum can be computed based on zonal wind data. Assuming the total angular momentum of the mantle—atmosphere system to be constant, variations in the rotation of the Earth are deduced.

The outcome of these experiments has been published recently (*Science* **224** 957). It is indeed remarkable that all three results are in good agreement, qualitatively and to a lesser extent quantitatively. This is gratifying if we keep in mind the minute changes the experiments were meant to detect. Even the maximum change observed in the length of day is a mere 3.1 milliseconds (the excess length over 24 hours). However, the dominant cause of changes in the Earth's spin rate seems to be an exchange of angular momentum between the mantle and the atmosphere. The authors also point out that the period during which there was maximum change in the length of day (corresponding to rapid changes in Earth's rotation) coincides with the strongest episode of El Nino recorded in the past few decades (El Nino is the appearance of anomalously warm sea surface temperatures along the coast of Peru).

What other information can be gleaned from these VLBI and SLR results which are influenced by the interactions of the mantle with the atmosphere and oceans is yet to be seen. Right now it appears that the experimental techniques have taken us far beyond the shores of our theoretical understanding of the dynamics of the Earth.

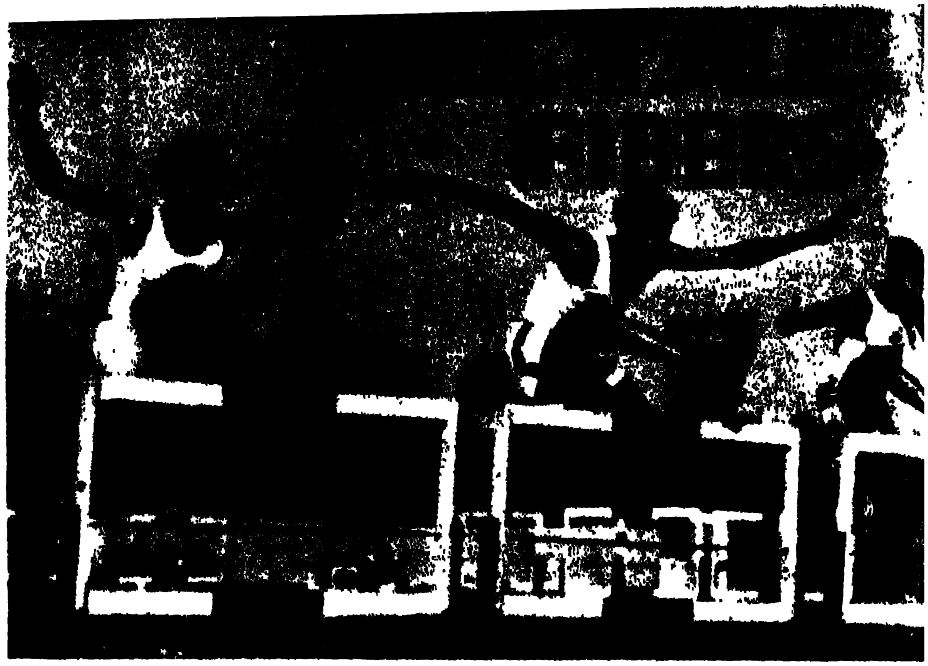
Indira Murthy

Dr. (Mrs.) Murthy is on the editorial staff of SCIENCE TODAY

THE remarkable improvements in the standards of athletic performances during the past few decades represent a unique biological phenomenon. It was inconceivable even a decade ago, that some of the earlier established athletic records could be improved upon within such a short span. Apart from the phenomenal progress in training methods, techniques and improvements in tools, equipment, tracks, and various other associated factors which contribute in shaping a world class athlete, genetically endowed human potential seems to play a great role in the final outcome, everything else being equal. However, the nature of the contributory role of the genetic factor in sports events is still a mystery. Perhaps in a few years with the rapid advances in the field of genetics, a clearer picture will soon emerge.

Search and selection of potential athletes in specific fields based on scientific knowledge, is a matter of routine in many developed countries. Unfortunately in India, this aspect has not been given serious consideration. As a result, athletes are selected from the 'available pool' mainly on the basis of their performance records in various sports meets. It is often forgotten that such 'talents' have already reached their maximum peak with little scope for further spectacular improvement in spite of intense grooming schedules. Therefore, a fresh look needs to be taken to improve upon the methods of selection of Indian athletes. They need to be identified at a very young age.

During the last decade, in many advanced countries the muscle biopsy technique, whereby samples from skeletal muscles of healthy people are obtained, has been widely applied 'to catch them young'. Recently, histological and histochemical techniques have also been applied to identify different fiber types in the skeletal muscle of man. This is then used to correlate the contractile characteristics to their function and metabolic potentialities in various athletic events by determining different enzyme activities.



Biopsy technique with Bergstrom needle

Two to four ml of one per cent lignocaine is infiltrated into the skin and sub-cutaneous tissues down to the deep fascia, after shaving and disinfecting the skin over the muscle to be biopsied. The biopsy needle is introduced through a four mm incision in the skin and subcutaneous tissue made with a surgical blade. The needle is advanced till the tip is about three to five cm below the skin surface and a sample of tissue is guillotined with the hollow cylinder and secured within the barrel of the needle, which is then rapidly withdrawn from the muscle. Several biopsy specimens can be collected over a span of time for histological, histochemical and metabolic studies.

The edges of the skin incisions are later opposed with a sterile adhesive material. The incision heals within three to four days. Hence, this technique can be used in a laboratory, ward or clinic without the need for surgical expertise and operation theatre facilities. It is remarkably non-traumatic. The residual sensation is one of moderate muscle stiffness, such as would follow unaccustomed strenuous exercise. This clears in a few days. Muscle function is hardly impaired by this procedure, since the subjects continue to compete in strenuous cross-country races after several biopsies.

The biopsy technique yields a sample which generally has a wet weight of 20 to 25 mg. For morphological or histochemical studies, there is no need to weigh the sample, but for all other analyses accurate weighing is essential. Weighing is done in an electrobalance for enzymatic and other micro estimations. Weight is plotted against time for a short time to allow for the effect of water evaporation by extrapolation to the zero time. For estimation of metabolites, it is essential to arrest the metabolism as quickly as possible. This is done by freezing the sample in liquid freon or nitrogen at $-150^{\circ}C$. Connective tissue and blood are removed before preparing the histological sections in a cryostat, which provides a low temperature and controlled environment. Samples for electron microscopy are fixed immediately in three per cent gluteraldehyde and subsequently treated by conventional techniques.

Classification of skeletal muscle fibers in man

The smallest unit in a muscle which can be activated for contraction is the muscle fiber unit. The muscle fibers in a unit, have identical characteristics. The classical terminology of red and white muscle fibers was based on the colour of the fibers which in turn was related to the muscle myoglobin content. The activities of the mitochondrial enzymes are, in turn, related to myoglobin content, while the content of sarcoplasmatic glycolytic enzymes are inversely related to the oxidative enzymes and myoglobin content. Stains for glycolytic or oxidative enzymes as well as for myoglobin give rise to a variety of staining intensities. A

Muscle biopsy technique, routinely carried out in the West, offers a new approach for judging athletic potentiality

KUNDAL LAL

division of fibers into two different types, slow twitch (type I) and fast twitch (type II) can, therefore, be made based on these properties.

In 1962, Engel suggested the use of a stain for myofibrillar ATPase (a muscle enzyme) after alkaline preincubation. This method separates muscle fibers into two well-defined groups. He proposed the names type I and II fibers for those fibers staining light and dark respectively. The type I fibers are to have slow and the type II fibers to have fast contraction times. By adding a stain for a mitochondrial enzyme, a sub-division of the type II fibers is possible, one type with a high and another with a low oxidative potential.

These are named as type IIa and IIb respectively. Thus, depending on contracile, metabolic and functional properties, muscle fibers in skeletal muscle of man can be divided into three distinct types.

Contractile characteristics of the fibers along with quantitative data of the metabolic profile suggest that a coupling between the characteristics of a fiber and its function exists in man. Hence, we have two main types, slow twitch (ST) and fast twitch (FT) fibers, with the latter having FTa and FTb subgroups.

Muscle fiber composition in skeletal muscles

The most commonly studied muscle in man is the lateral portion of the thigh (vastus lateralis). The fiber composition of large number of young men and women indicated a mean value of 52 per cent for the ST fiber (out of total fibers) for both sexes. Within the group of FT fibers, the FTa fibers were approximately twice the FTb fibers, the mean values being 33 and 14 per cent respectively. Ample evidences are now available suggesting that no difference exists between males and females in this respect. However, in both the sexes, a wide variation in fiber composition between individuals exists, which is more pronounced in the males.

Regarding the size of the fibers in general, cross sectional areas of the fibers are larger in male than in female muscle. In man, the mean cross sectional area of the FT fibers of the thigh is larger than the mean area of ST fiber. In sedentary women the ST fiber is larger than the FTa; in both the sexes FTb fiber being the smaller. All fiber types can respond to increased activity with some enlargement of the size of the fiber.

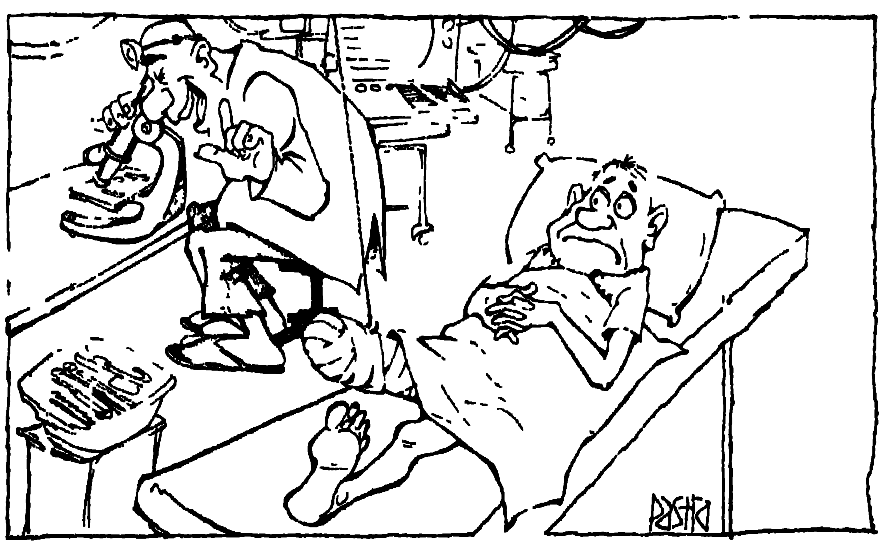
What about the fiber composition in different muscles of the same subject? The available data demonstrate that there are rather close similarities between some muscles, whereas other muscles have a more pronounced predominance of one fiber type. The vastus lateralis, rectus femoris and gastrocnemius muscles of the legs and the deltoid and biceps muscles of the arms appear to contain about 50 per cent ST and 50 per cent FT fibers. On the other hand, the soleus muscles have 25 to 40 per cent more ST fibers than the other leg muscles and the triceps muscle 10 to 30 per cent more FT fibers than the other arm muscles. Most of the skeletal muscles of man are so homogenously mixed that although they may have special functions demanding a special fiber type, all muscles are also involved in other activities where the characteristics of different fiber types are needed.

Muscle fiber composition of athletes

During the last decade, it has become popular to determine muscle fiber composition of athletes involved in different types of events. Regarding the relative distribution of ST and FT fibers, the most interesting findings are that sprinters have a marked predominance of FT fibers in their leg muscles. The opposite is true for long distance runners. Throwers, weight lifters and high jumpers generally have an even distribution of fiber types in their leg and arm muscles. Both sexes are similar in this respect (Table 1).

The findings on distance runners and sprinters fit with what is known about the special characteristics of different types of fibers. It may be explained that in sprinting there is a greater demand on FT fibers as they

Congrats! Your muscle biopsy's positive... you'll make a great runner!



Type of athletes	% ST Fibers	% FT fibers
Sprinters	24.0	76.0
Middle distance runners	51.9	48.1
Distance runners	69.4	30.6
Jumpers	46.7	53.3
Shotput and disc throwers	37.7	62.3
Untrained	52.6	47.4

Table 1:—Fiber distribution in different classes of athletes

fatigue quickly. The possibility also exists that in athletic performances where a single contraction of one or two groups of muscles is of importance for success, a high degree of synchronous activation of fibers is required. Endurance trained subjects have a high occurrence of FTa fibers and few or no FTb fibers in the muscles involved in training. Muscle groups partially or not at all engaged in exercises have some or a normal content of FTb fibers. It can, therefore, be suggested that the lack of FTb fibers is part of an adaptive response to the endurance training. Based on these observations, the ideal distribution of fibers in different classes of runners can be established (Table 2).

Aerobic—anaerobic capacity of voluntary muscles

Carbohydrates and fats are the main sources of energy for muscular contraction. Special chemical compounds act as carriers of energy within the cell, from the energy depots to the point where biologically meaningful reactions take place.

The ability of an athlete to sustain activity by means of the oxidative release of energy is dependent on oxygen utilisation and oxygen delivery. Just as fast-twitch muscle fibers are important to anaerobic activity, slow-twitch fibers are essential to aerobic activity. Slow twitch fibers are characterised by a higher content of myoglobin (a compound similar to hemoglobin, the oxygen carrying compound of the red blood cells) and by greater capacities of the enzyme systems involved in oxidative energy release. Therefore, muscles with a higher population of slow twitch fibers are better able to sustain long lasting aerobic activity. If the aerobic mechanisms of the individual cells have been enhanced by appropriate conditioning techniques, the muscles will have even greater capacities for such exercises. Appropriate increase in capillarisation accompany increases in slow twitch fibers.

The energy release of a single maximal effort, as in a strength movement, depends on energy obtained from the splitting of the high energy phospate compounds, ATP and creatine phosphate. No molecular oxygen is involved in these metabolic processes; they are anaerobic. However, the term anaerobic power in sports performance is more often used to describe high intensity activity that lasts approximately five seconds to one minute. This is the range in which the capacity of the high energy phosphate compounds dominates.

Anaerobic glycolysis (lactate formation) becomes more important as work intensity decreases and performance time increases. Fast twitch muscle fibers have a greater capacity for glycolysis than slow twitch fibers. Thus, the percentage of fast twitch fibers is important for anaerobic performance. Also, the glycolytic capacities of the individual fast twitch fibers are very responsive to conditioning.

Metabolic profile of skeletal muscles of athletes

Results from several longitudinal studies indicate that human muscles are adaptable to oxidative capacity. Succinate dehydrogenase (SDH) activity of quadriceps muscle increased by 30 per cent. This was paralleled by a similar increase in the protein content of mitochondrial fraction. Elite distance runners and swimmers have

Oxidative enzymes' potential in muscle fibers

OXIDATIVE potential of voluntary muscles vary greatly depending on the training status of an individual, as well as the type of event trained for. Based on observations from various studies, it may be appropriate to consider Succinic Dehydrogenase (SDH) (an oxidative enzyme) activity in the vastus lateralis muscle of approximately 7 mM/kg × min as a normal value for sedentary subjects; while elite distance runners have SDH activities of 20 to 25 mM/kg × min. Physical inactivity results in a pronounced decrease in the SDH activity (approximately 3 to 4 mM/kg × min).

Both the major fiber types of human skeletal muscles are adaptable to oxidative potential. An interesting observation is that in skeletal muscles of highly trained cross-country runners who contain very few FTb fibers, the SDH activity in FT fibers has been found to be as high as in the ST fibers. This would suggest that the maximal level of oxidative potential that can be attained with intense endurance training, is the same for ST and FT fibers. On the other hand, findings such as the high percentage of ST fibers in skeletal muscle of successful long distance runners and the reported relation between the ranking order of top level endurance athletes and the percentage of ST fibers in their leg muscles suggest that muscle fiber type distribution may set an upper limit for the degree of oxidative enzyme adaptation that can occur in skeletal muscles in response to training.

J. S. S.
K. C. S.

EVA SERENY, CAMERA PRESS LTD.

Our athletes need to be identified at a very young age. These young, Italian swimmers perhaps *will be tomorrow's Olympic stars*

demonstrated three to four times higher SDH activity than the untrained. A high oxidative capacity may enable the muscle to extract more oxygen from the blood during maximal exercise thus increasing the maximum oxygen supply capacity.

It has also been suggested that higher oxidative capacity of muscles in endurance athletes may be responsible for lower lactate levels, slower rates of glycogen depletion and lower RQ during maximal efforts. In the muscles of endurance athletes the glycolytic enzymes appear to have the same or a slightly reduced activity as compared with untrained subjects. The activities of lactic dehydrogenases and hexokinases follow the profile of oxidative enzymes. Glycogen content is usually somewhat higher in trained than untrained muscles. It is not yet known definitely whether triglyceride storage in skeletal muscles increases with endurance training or not.

A question may now be posed, whether muscle fiber ratio is changed or not due to athletic training. In reply, it has been convincingly shown in several studies that the percentage distribution of fiber types in man does not change following endurance, sprint or weight resistance training. Recent evidences on monozygous (identical) and dizygous (fraternal) twins have strongly indicated that fiber type distribution in man is solely determined by heredity. In addition, other neuromuscular factors like reflex time, reaction time, and muscular power are also genetically controlled. Hence speed and agility factors in an athlete are highly genetic. Thus, the old saying "sprinters are born and not made" may have some truth in it.

Endurance athletes on the other hand are born predominantly with ST fibers, with metabolic potentials responsive to intensive training. It can therefore, be concluded that endurance athletes are born and then made. It, therefore, goes without saying that if these genetical endowments, coupled with proper physique, are identified at an early age and proper training is imparted to these potential athletes, there is a chance that they will succeed in olympic arena, or in any world competitions. □

Table 2:—Ideal distribution of fibers

Event	100 m	200 m	400 m	1500 m	Marathon
% ST	10-25	[illegible]25	30	57	[illegible]-80
% [illegible]	[illegible]	[illegible]	70	[illegible]	[illegible]
Importance of aerobic capacity	None	Low	Low	M[illegible]-High	High
Importance of anaero bic capacity	Very high	Very high	High	Moderate	Moderate

Dr. Sen Gupta is the Deputy Director (Physiology) and Capt. Sinha is the Director at the Defence Institute of Physiology and Allied Sciences, Delhi Cantt.-110010

ADVT. NO. 2/84

PLASMA PHYSICS PROGRAMME

being nucleated at

PHYSICAL RESEARCH LABORATORY
NAVRANGPURA, AHMEDABAD 380009

REQUIRES

PHYSICISTS

The plasma Physics Programme, a major research programme sponsored by the Dept. of Science and Technology, Govt. of India, as a part of their programme on Intensification of Research in High Priority Areas, is being nucleated at the Physical Research Laboratory, Ahmedabad. The Programme is looking for

PHYSICISTS

Job Descriptions: The Physicists will work on the development of conventional and nonconventional plasma diagnostic instrumentation, toroidal plasma confinement experimental systems and will carry out research on topical problems of high temperature plasmas.

Qualification & Experience: Ph D with experimental work in any branch of Physics such as Solid state physics, Plasma Physics, Nuclear physics, X-rays & Crystallography, Spectroscopy, Atomic & Molecular Physics etc Candidates with Theoretical numerical analysis background and those with Ph D in Applied Mathematics may also apply Adequate experience in these fields are desirable

The selected candidates will be placed in the following or a higher grade depending on the expertise, merit and the relevant experience in the related fields of Plasma Physics

Rs. 700-40-900-EB-40-1100-50-1300 (Total emoluments at the minimum of the grade come to Rs 1802/- per month at present).

Rs. 1100-70-1450 (Total emoluments at the minimum of the grade come to Rs 2555/- per month at present)

General

The funds for the plasma physics a project are sanctioned upto 31-3-1986 and it is likely to continue beyond this period In addition to pay and other allowances perquisites like Provident-Fund, Gratuity, Leave Travel Concession, Contributory medical facility etc will be admissible as per rules In exceptional cases of merit additional increments may be granted. Outstation candidates called for interview for the posts below the grade of 1100 would be paid to and fro second class railway fare and for the post including and above the grade of 1100 would be paid first class railway fare by the shortest route Applications may reach in the prescribed form available from the Asst Admn. Officer, Plasma Physics Programme, Room No 552, PRL, Navrangpura, Ahmedabad 380 009 by sending a self addressed and stamped (70 paise) envelope on or before July 31, 1984 The envelope should be superscribed with the post applied for on the left hand corner. Candidates employed in Government/Quasi Government/Public Sector undertaking should forward their applications through proper channel No interim correspondence would be entertained Incomplete applications are liable to be rejected.

IN the 1960s, research engineers in Sweden and USA were looking for an innovative, long-lasting and all-weather surface for sports and recreation. The product was a synthetic track. And in the Mexico Olympics in 1968, for the first time, athletes ran a race on a synthetic surface instead of the usual cinder track. In 1976, a synthetic hockey field was used in the Montreal Olympics in Canada.

Immediately after the 1976 Olympic Games, almost all hockey-playing countries like Holland, West Germany, Australia and Pakistan went in for synthetic turf and improved their performances in international hockey competitions.

India, though, was a late starter: synthetic turf was first used in India in the 1982 Asian Games, and since then the Indian team has been constantly practising on this surface. The result: its performances in the recently concluded international competitions in Kuwait and West Germany have been

ASHOK VAHIE

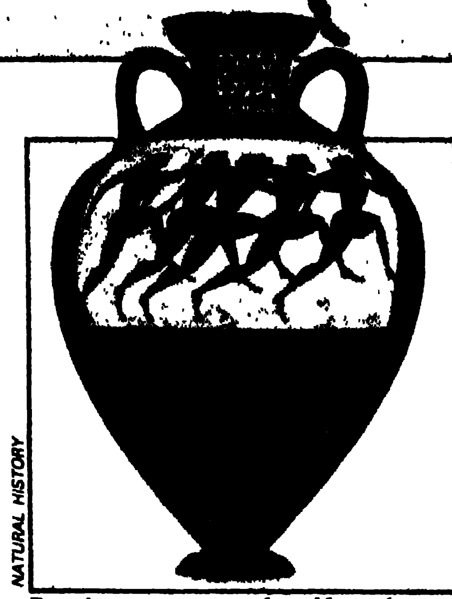
Left (top and middle): ***Synthetic surfaces used for hockey.*** **Bottom:** ***A close-up of synthetic grass fibres on a playing field***

Above: ***Athletics on a synthetic track***

rated one of the best in recent years. Technology and training have indeed improved performances on the field.

Synthetic turf has affected the style and technique of playing hockey in recent years. In general, teams with better physiques and greater endurance have been able to better adapt to these surfaces. And those who use a 'hit and run' technique are more successful than teams which depend on short passes and individual stickwork. That is why European teams like Holland and West Germany take greater advantage of such artificial surfaces by adapting a hard-hitting and long and cross-passing style of play. Because of the sureness of the surface, hard-hitting and stopping have become common. Another technique used on synthetic turf is the overhead long pass. At the same time, old techniques like the reverse stop on the run, the reverse pass on the move, the reverse flick during play and reverse hitting is difficult on synthetic turf.

What are synthetic turfs made of? These are synthetic grass tapes knitted together with high stability polyster or nylon fibres. Layers of these synthetic



NATURAL HISTORY

Running races were the oldest class of event at the ancient Olympics. This ancient ampora* (above) *found at Olympia, the site of the original Olympics in ancient Greece, has runners* (top) *inscribed on it

grass mats are laid on top of a specially prepared conventional pavement, all done with great care to ensure a perfect finished surface. Usually, two-metre wide rolls are laid on the prepared surfaces and sewn together with a special sewing machine. The sewn length of the rolls is covered on the back with a broad band. The rolls are then fixed at the edge of the pitch. Usually a concrete curb is constructed around the pitch. The synthetic surface is tucked over and anchored to a wood nailer which is attached to the concrete curb.

For track and field events, polyurethane rubber and composite surfaces are used. In some cases, where the surface is pre-fabricated, it has a reselient rubber matting base. The surfaces are spike-resistant, with a bounce and involving very low energy loss. They are also slip-proof and could be used throughout the year.

In fact, synthetic surfaces have made play or training possible throughout the year; rain, drought, frost and snow make no difference to the condition of the field. One could train everyday, use the field as much as possible and still the surface remains trouble-free. Modern athletes have demanded artificial surfaces for two reasons—to improve their performance, and to train continuously without fatigue and danger of injuries.

A good sports performance demands

that the track or the floor should be sufficiently elastic and resilient under a wide temperature range, should have a low energy loss and a cushioning effect; it should not skid in dry or wet conditions and the flooring should revert to its original position immediately after pressure. Similarly, a good playing field should have a well-balanced surface, good elasticity, resistance to abrasion and lower accident risks; it should help increase efficiency and reduce fatigue.

For running, the ideal would be a surface that imparted a high force in the direction of running and a reaction force (of the surface against the shoe and the body; the harder the surface, the higher is this force) to the body. It is also not good if the force transmitted to the body is too low, for, a certain upward reaction force is necessary to maintain the body's centre of gravity at a height comfortable for running. The surface should have a good "bounce". A good surface should also be able to absorb shocks in the range of the force generated in sprinting, middle distance running and jogging while still maintaining a reaction force.

In fact, the use of synthetic rubber tracks and the development of lighter running shoes have greatly improved running performances in recent times. According to some experts, it has chipped a second off for every lap, creating new world records. And if Jesse Owens, one of the greatest sprinters of this century, and who won the 1936 Olympics 100-metres sprint with a timing of 10.3 seconds, were to run today, he would have matched today's world record of 9.95 for the event. That is what a computer analysis showed. But back in 1936, "the track did not have the rebounding characteristics of today's surfaces", says Gideon Ariel, a US physiologist who did the computer analysis. Besides, Owens also didn't have the starting blocks and his foot slipped slightly on the track. "The human body hasn't evolved much in the past 100 years", says Ariel. "All the changes we are seeing today come as a result of improved technology and training."

Synthetic surfaces have several advantages over conventional fields. Synthetic fields can be used in all weather conditions and they afford play under same ground conditions. Several matches could be played in a day on a synthetic turf (say six to eight matches a day). While one can play for about 500 hours a year on a conventional pitch, one can play up to 3500 hours or more on a synthetic pitch. With floodlights, one synthetic field can replace five conventional pitches. Besides, maintenance is minimum; once the pitch is laid permanently, all that it needs is occasional cleaning and watering. An artificial surface can last about five to seven years.

Originally, the race track at Olympia was an open, level stretch of ground with a line drawn in the sand to mark the start. Later, in 350 BC, a new stadium (below) was built and it had a straight track made of clay lightly covered with sand. Stone sills at each end marked the start and finish

PAUL SLAUGHTER/NATURAL HISTORY

There are some disadvantages, however, of playing hockey on a synthetic turf. Players with weak physiques, for example, cannot withstand the pressure of play on synthetic turf as the actual playing period is much more as compared to playing on natural turf. The ball gets faster on synthetic turf; it was timed that a good shot from a panalty corner into the goal takes 1.3 seconds on synthetic turf while it takes around 1.9 seconds on natural grass. Hence the goal-keeper gets a shorter time to react. Muscle sprains are more on synthetic turf, and also there is a higher wear and tear of body muscles. Thus playing on synthetic turf leaves greater after-effects.

Synthetic surfaces are also used for badminton, volleyball, etc. For badminton, plastic-coated rubber sheets are used on a jute or felt-backed PVC base. Volleyball courts use polyurethane surfaces. These surfaces are usually taped on a wooden flooring.

Though artificial surfaces have pushed up the cost factor in conducting international sports competitions, performances of atheletes and players have gone up manifold. And so has the confidence of sports organisers. This is because they are more confident of completing the games and have no anxiety about ground conditions owing to bad weather.

Of course, a good and true grass surface could be made in countries like India at a much lower cost, but one would not be able to control ground conditions under bad weather. Whether we like it or not, synthetic surfaces have come to stay in many games and have been approved by the international sports federations. We may as well accept them and try to develop the facilities so that our international sportsmen and younger athletes get the benefit of training on these surfaces. □

Dr Muthiah is Joint Director of the National Institute of Sports, Patiala

MATHEMATICS OF HOPE

B. A. Naik

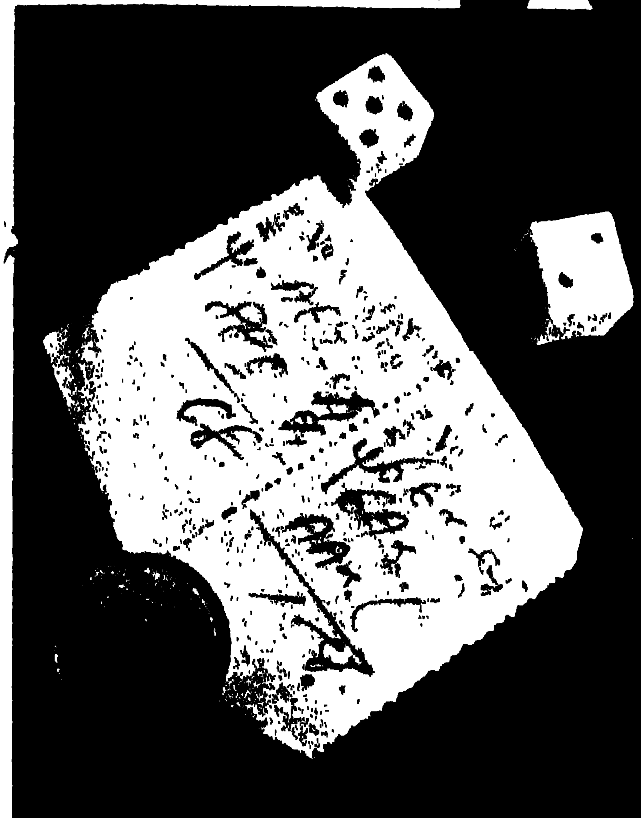
A Sanskrit proverb describes hope as a strange chain, one that enables those bound by it to fly; those who unfetter themselves, however, are condemned to crawl or stand stock-still! It is the hope of making a financial fortune that drives us to buy lottery tickets. But when you take a hard-headed mathematical look at the probability of your winning a windfall, hope acquires an altogether different aspect

B C CHANDA

RAMA was a humble bidi-worker, one of the many people who throng daily to the lottery stalls — the purveyors of hope. However, what distinguishes this bidi-worker of Chhana Patana, Karnataka, is his persistence: He had been buying lotteries day after day for the last 18 years, spending nearly a third of his meagre 600 rupees per month income on his quest for a windfall. Then one day Rama's fortunes changed. He won a "bumper" first prize and overnight became a "master of sixty-one lakhs". "Lakhpati" Rama was as laconic after his success as before: "Man's best successes come after many disappointments!" he said.

Rama is undeniably a fortune's favourite. But how many such success stories can one cite? It's literally one in a million situation. The chances of 99.9999 per cent of cases are so slim as to prove the addage—"Hope lives for ever but her children die one by one."

When you buy a lottery ticket what is the mathematical probability of your



—B C. CHANDA—

winning the Ist price?

In simple terms, *probability* may be defined as the ratio of favourable cases to the whole number of cases possible e.g. if there are 10 tickets bearing numbers 1 to 10 and a prize is declared for a single specified number drawn the probability of a single ticket holder winning will be 0.1. Because the number of tickets issued is 10 while there can only be a single ticket beating the winning number.

If you purchase more tickets the probability is multiplied by that number. Naturally if you buy five tickets your probability of winning will be $5 \times 0.1 = 0.5$.

Let us take another example. A lottery ticket bears a seven-digited number and a prize of Rs. 5 is declared for all numbers bearing the specified last two digits. Here while calculating the probability of winning we are not concerned with the initial five digits; we have to only consider the last two digits which can only be from 00 to 99. Suppose the winning number is 38 which can only occur once in the range 00 to 99. Thus the probability of your number being the lucky one becomes 1 in 100 or .01.

If by some trick you can corner all the 100 tickets within the series with 00 to 99 as the last digits, only then can you hope to win the prize. The probability of winning in such a case then becomes 100 per cent. Mathematically that works out to: 100 tickets, each with the probability of $.01 = 1$. Therefore, when you say the probability of your winning is a unit or 1 we mean you cannot lose.

You have succeeded in making your victory fool-proof. But what if you are cheated out of your prize by some forgerer. In that case despite purchasing all the tickets, your probability of winning becomes a big zero!

Again by cornering all the 100 tickets and ensuring that you have cent per cent probability of winning, you are not only losing out on the excitement of lottery but also on money!

That brings us to the concept of mathematical hope which is defined as the product of the amount the buyer hopes to win and the probability of his winning it. Let's take an example. Suppose in a series of ten lakh tickets, with the 1st prize of Rs. one lakh, you buy one ticket. Then your mathematical hope on a single ticket works out to Rs. 1 lakh × 1/10 lakhs = Rs. 0.10 or 10 paise.

Since each ticket costs 100 paise one can at once see why lotteries largely favour the organisers!

It is possible to make up the difference between the mathematical hope and the cost of hope if in some cases if a player is a rich and plays systematically. Let us take a simple example. Suppose a coin is tossed for heads or tails. And the better wins and gets twice the amount staked. The strategy of a rich and patient player would be to double up the stake everytime he bets, eg the player stakes one rupee for the first bet, two for the second, four for the third and so on.

Suppose he plays 10 bets and is unlucky in the first 9 bets but fortunately wins in the last bet (he should play consistently till he wins) he still stands to gain. How? The total amount staked in 10 bets is equal to 1+2+4+8+16+32+64+128+256+512 = 1023 and the amount gained in last bet
= 2 × amount staked in last
=2 × 512
=1024 which is a rupee more than the total amount spent. This proves the whimsical addage "Heads I win tails you lose!". And it also shows how money attracts money. A poor person cannot afford doubling the stakes as can a rich one and therefore the rich become richer while the poor become poorer!

That brings us to mathematically fair and unfair games. In a fair game if 1/n is the probability then your prize amount should be n times the amount staked. For instance, in the case above when a coin is flipped, the probability of your being right is ½ (because there are only two possibilities: heads and tails); and the prize amount is twice the amount staked. Hence it is a "fair" game.

Now suppose instead of a coin we use dice. Since a die has six faces the probability of getting a particular face right is 1/6. Thus in order to be fair, the prize amount should be six times the stakes.

Unlike this simple coin-tossing or dice-throwing a lottery cannot be "fair" mathematically. It is not a mere game or a gamble. The avowed purpose of lotteries is to raise money for welfare. For one thing the number of tickets is always much larger than the prize amount 9 (which in most cases does not range beyond 50 per cent of takings). And the probability of your making a profit by cornering all tickets is never equal to unity.

Mathematics of probability probably began around 1652 when Chevalier de Mere, a gambler friend of the great mathematician Blaise Pascal wanted to know the division of stakes in an unfinished game of dice. Surprisingly, a magistrate and a par-time mathematician Pierre de Fermat also got interested in this and allied problems of that noble gambler who was a mere catalyst to the gensis of Probability Theory. Historians have recently found that the Italian mathematician Jerome Cardon (1501-1576) had also done pioneering work in the field. He dealt with some fundamental problems of probability in his classic *Liber de Ludo Alae:* Little Gamblers' Manual.

Whoever sir'ed probability theory first, it is certain that the uncertain nature of the game of chance gave birth to a new branch of mathematics with a wide range of applications.

Gambling is as old as civilisation. There is hardly any event or an activity on which one cannot wager. In the Bhagvadgita Sri Krishna proclaims "In

Some call it blind chance!

The lowdown on lotteries

THE Lottery was an invention of the early Romans. Lotteries in the modern sense originated in Italy in the Middle Ages. The earliest state lottery was conducted in France in 1520. The idea spread to England, Ireland, Germany, France, Spain, Switzerland, Russia, USA and Australia. Its spread to the Eastern part of the world is of recent origin.

During 1944, the first official attempt was made in India to raise funds through a lottery by way of the prize bond scheme of 1944. In 1960, the second prize bonds were issued. In 1963 and 1964 premium prize bonds were issued. Kerala started the state lottery in December 1967—the first state in India to do so.

Punjab in July 1968 followed suit, with Tamil Nadu and Haryana on close heels. Rajasthan started it on January 1, 1969.

Mr. C. Rajagopalachari was the first statesman to raise voice against states starting their own lotteries. In his opinion, the centre alone had the legal power to start a lottery.

According to the Reserve Bank of India, the total collection from lotteries was Rs. 48.0 crores in 1980-81, budgeted estimate was Rs. 89.7 crores in 1982-83.

Out of eighteen states which float lotteries in India, major are: Andhra Pradesh, Gujarat, Haryana, Karnataka, Kerala, Maharashtra, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal.

While these states have their monthly draws some of these states have a daily draw too like the popular Maharashtra mini-lottery. Around 26 guaranteed lotteries are held every week and 124 draws a week.

Agents get anything between 15 per cent to 50 per cent of commission on tickets sold. The breakdown is as below:

Commission offered	state
15 per cent	Tamil Nadu, Gujarat and Maharashtra
20 per cent	Manipur, Pondicherry and Meghalaya
25 per cent	Sikkim, Delhi and West Bengal
30 per cent	Karnataka
50 per cent	Nagaland, Chandigarh, Punjab Red Cross and Haryana Red Cross

A lottery prize is subjected to a 33⅓ per cent tax. Besides some states also deduct the agents' commission, publicity and other expenses in addition to the tax.

A Supreme Court ruling removed restrictions on inter-state sale of lotteries.

The prize money varies from lottery to lottery, first prize being over a couple of crores of rupees—the highest-to Re. 1 being the lowest for a daily draw in Maharashtra, while for a weekly draw the prize range is Rs. 1 lakh to Rs. 2 only.

Revenue and expenditure on lottery differs from state to state. In Maharashtra, about 55 per cent of the returns on sale of lottery tickets is spent on prizes and 15 per cent on commission to agents.

Distribution costs of lotteries work out to something like 25 per cent of gross collection for commission and bonus for distributors and dealers, 10 per cent for administrative expenditure, 40 per cent as prize money (including income-tax to Central government) and 25 per cent to the state government as net revenue.

While persons in different ranges of incomes participate in the "legalised gambling'—lottery—55 per cent belong to the group earning below Rs. 1.000 per annum, 26.4 per cent within the range of Rs. 1,000-Rs. 1,500 and 13 per cent in the range of Rs. 1,500-Rs. 3,000 per annum—according to a Survey. Thus, lotteries appear to be a poor man's gambling with 81 per cent of population participating in lotteries being poor.

The periodicity of payment of prize money to the successful drawers varies from state to state—less than three weeks in the case of Maharashtra to over twenty-eight weeks in the case of West Bengal and upto 18 months or more, occasionally, in the case of Rajasthan and Haryana

Lottery, very often, condemned as 'legalised gambling' has stirred a hornest's nest. The term 'lottery' is defined as "gamble in which part of money paid for tickets is distributed by lot among some of the holders."

Lottery has descended down the ages to the modern times. The largest of the American lotteries and perhaps the most controversial for the charges of corruption involved was the Louisiana state lottery licenced in 1868. It was closed down in1893.

The List II in the Seventh Schedule of the Indian Constitution, the State List—includes betting or gambling in item No. 34; stretching the meaning and scope of the term to enable the state legislatures to make laws regarding lotteries too. However, item No. 40 in the Union List reads: "Lotteries organised by the government of India or the government of a state means the Parliament has exclusive powers to make laws regarding lotteries or licence them."

The Law Ministry opined that the lotteries run by the states are unconstitutional.

Lotteries are defended on the grounds of revenue-earners, employment generators and resource mobilizers for social welfare schemes of the governments. They are condemned as being a discreditable way of raising money' (C. Rajagopalachari) unconstitutional, unethical, anti-poor and launderer of black money. Revenue raised by way of lotteries is claimed to be either not spent on social schemes or too meagre to matter.

S. R. Kasbekar

the wicked I am the instinct of gambling". Indeed, we owe the entire Mahabharata to a fateful game of dice. Even our Vedas talk of gambling. The modern games of chance include craps, baccarat, roulette, horse racing and lottery. Since gambling is denounced by almost all religions one may arguably leave out horse racing and lottery from the fold of gambling. One can view them as games of chance plus skill.

Dice: The six faces of a dice are marked with a number of small dots ranging from one to six. One, two or more dice are thrown at a time and the player has to predict the outcome in advance. For craps, the most popular gambling game in the U.S. two dice are used while for a game of chuck-a-luck, three dice are needed.

One of the favourite games in gambling houses is "Roulette". This originated in France. The wheel at Monte Carlo is divided into 37 equal compartments numbered from 0 to 36 and alternatively coloured red and black. A ball is thrown onto the spinning wheel which comes to a halt, on some number with a certain colour. The player has to guess the number and the colour in advance.

Ultimately it all boils down to chance. Life itself is a great game of chance. The genetic code is like a tarrot pack. Each random shuffling of the cards produces a unique set of characters and qualities in an individual. Equally unpredictable circumstances and chance encounters produce unforeseen effects: a brilliant mathematician like Galois can end up in jail over a brawl over political views. He can then stay up to write a revolutionary concept in mathematics—and die the next morning in a tragic duel! □

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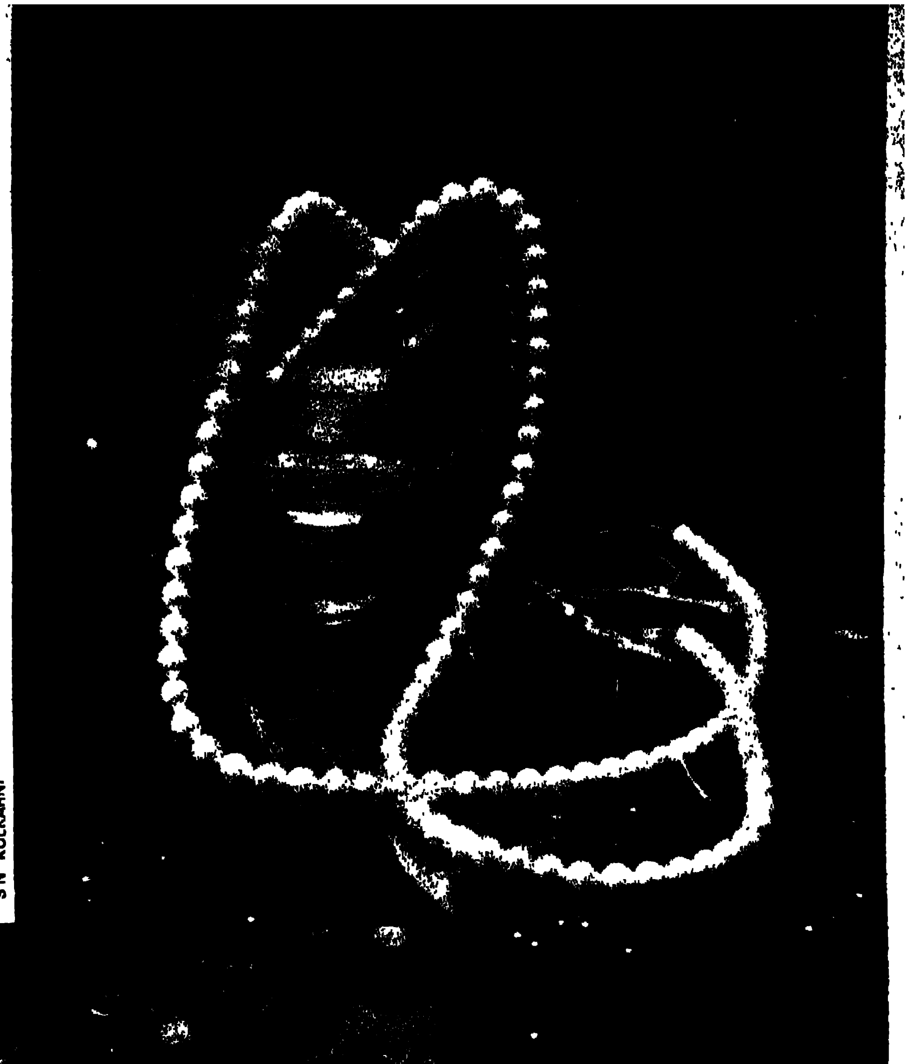
PRIMING OF PEARLS

These shining "beads" secreted inside oysters hidden in the ocean depths are among the most coveted natural treasures

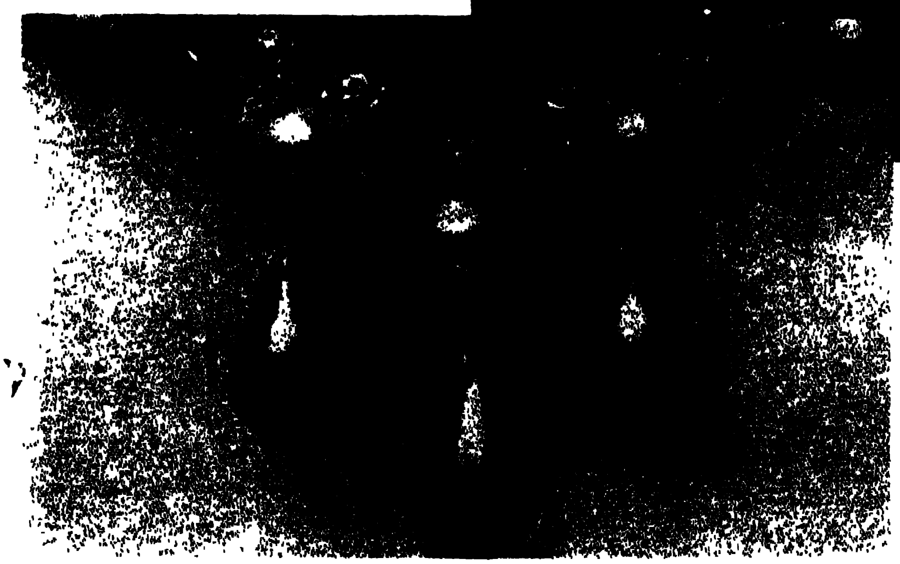
S N KULKARNI

MEN have been intrigued... fascinated... even obsessed by pearls. And no wonder, for each pearl has been endowed by Nature with its irresistible allure, its own inimitable beauty. Cleopatra is said to have toasted a glass of wine containing a pearl to the health of Mark Antony. Poets and lovers have found an apt expression—"a string of pearls" to describe a beautiful woman's smile. Indian mythology prescribed pearls in the form of *bhusma* for longevity, vigour and vitality. Wonders never cease when one comes to learn about the origin of these glittering pearls. Only during self-defence pearl-oysters form pearls in the bosom of the sea which then become our cherished possession.

There are two major groups of pearl-oysters in which gem pearls may form. The salt-water pearl-oyster, Pinctada, of which there are several species and a number of genera of fresh water clams. Usually jewellers refer to salt-water pearls as Oriental pearls.



S N KULKARNI



Pearl-oysters inhabit the tropical seas, especially in the Far East, Japan, Thailand, Persian Gulf, the east coast of India, Ceylon, Australia and the Gulf of Mexico. These oysters survive on planktons (floating aquatic plants) which are available mostly in warm waters.

One year old oyster is seven millimetres (mm) in diameter and is termed as an adult, its life span being only five years. The oyster is a bivalved mollusc having a shell with numerous hair-like structures with which it adheres itself to the pearl bed at the bottom of the ocean. The pearl bed is full of corals, sand and algae. If this pearl bed is disturbed, the oyster cannot survive.

Natural pearl formation

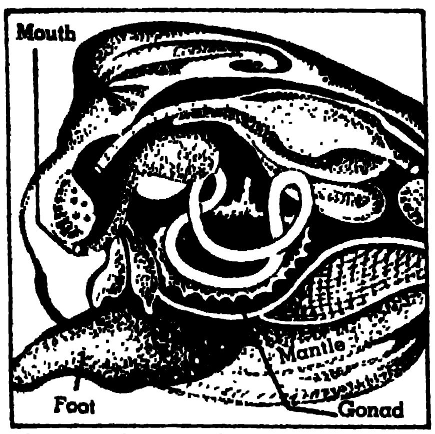
It is interesting to know how a pearl is formed. A tiny particle, either a parasite or a grain of sand (grit) inside the inner layer or the epithelial tissue of the mantle of the oyster, initiates the pearl formation. As a means of self-defence against the irritant, the oyster embeds this particle (nucleus) with the secretion from the inner layer of the shell. This is called the nacre or mother-of-pearl. Nacre consists of pseudohexagonal aragonite crystals held in place at right angles by conchiolin, a horn-like organic secretion. Chemical analysis of pearls show the presence of calcium carbonate, organic materials and water. These chemical components vary depending on several factors like the species of molluscs and the position of the nucleus within the shell.

The shine of a pearl is due to the small amount of water present within the pearl. Its lustre depends upon the thickness of the secretion deposited by the oyster around the nucleus. Lustre is caused by microscopic ripples in the thin layers of the semi-transparent nacre that forms the pearl. When light strikes the ripples, they act as prisms breaking the light into a spectrum of colours. The colour of pearl varies from pure white through pastel pinks, mauves, golds and greens to black pearls. Besides colour, the shapes of pearls vary from tiny smooth 'seed' pearls to large 'baroque' pearls. The most common and desirable shape is spherical or nearly spherical: this is the shape chosen for necklaces. Other desirable shapes include those called button, pear, egg and drop. When the pearl rests in the oyster cavity, it grows into a

Raft for suspending oysters implanted with the nucleus

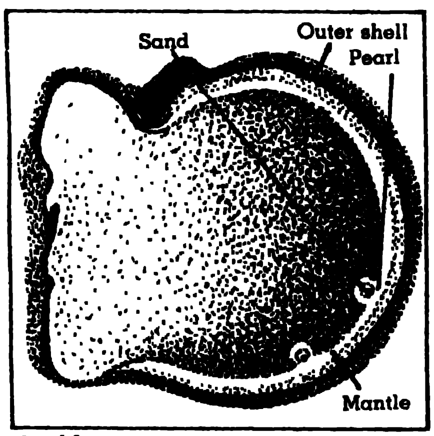
spherical shape. But, if it gets embedded in a muscle, its growth is slightly retarded resulting in an irregularly shaped pearl. Likewise, when the nuclei get lodged elsewhere in the body the pearls are irregularly shaped.

The divers who gather pearls, spend about 60 to 80 seconds under water and bring the oysters to the surface in baskets. The oysters are then broken open and the pearls extracted. But natural pearls and pearl-oysters have dwindled in size and today almost face extinction. Change in oceanic currents, deposition of toxic and polluting elements in the bottom of the sea constantly cause harm to the pearl bed. Hence, pearl-oysters are slowly disappearing. Natural fertilisation, a subsequent



The internal organs of a bivalve

ILLUSTRATED BY DHANANJAY SASTAKAR



Pearl formation

hatching of eggs, is a mere chance event in the sea. Each adult female oyster lays 20 million eggs, out of which 40 lakhs survive and mature However, the survival of young ones is rare There are imminent dangers, for the young ones are usually attacked by ray fish and are eaten away in large quantities The steep fall in numbers of pearl-oysters has motivated scientists to induce the oysters to spawn in the laboratory and rear them

Spawning pearl-oysters

The most important aspect of spawning oysters is the water management technique Sea water tested and filtered several times and subjected to ultraviolet rays to ensure bacteria-free water, is filled in specially prepared tanks Thereafter, a pearl bed with ideal conditions congenial to oysters in the sea, is created It is lined with corals or sponges with planktons around. The salinity and temperature of water is also scrupulously maintained. Once the tank is ready, male and female pearl-oysters are kept in the tank. Water in the tank is mixed with ammonium hydroxide which acts as a stimulant for males and females to discharge sperms and ovum respectively. External fertilisation takes place in the tank. Within twenty days the young ones or spats appear

These spats are reared in the tank. They are fed with planktons collected from the sea. The oysters enjoy a state of complete well-being in their new home. The survival rate of oysters in the tank is 20 per cent, as compared to two per cent present in the sea. Spawning oysters in laboratory is indeed an achievement. Dr. Alagarswami, a senior scientist and head of pearl culture branch of Central Marine Fisheries Research Institute (CMFRI), Cochin, and his colleagues have succeeded in developing and standardising this technique. Spawned oysters can then be used for culturing pearls

Cultured pearls

The Japanese and Chinese have perfected the pearl culture method in the last 100 years or more The first cultured pearls of India were produced in rafts immersed in the Gulf of Mannar (Tuticorn) by scientists from CMFRI in 1973. These pearls are produced by the pearl-oysters in a similar way as natural pearls. Adult oysters, either male or female, are collected from oceans and brought to the laboratory They are kept in a tank which is sprinkled with methanol. This has an anaesthetic effect on the oysters, which is needed to carry out a delicate surgery on them. A portion known as the graft tissue is removed from the margin of mantle tissue and a small particle from shell of a conch termed as nucleus, is implanted in the graft tissue. Through the foot region of the animal, an incision is made enabling the formation of a channel and then the nucleus wrapped in the graft tisue is slowly deposited in the gonad of the mollusc. The oysters implanted with the nucleus are then placed in a tank containing sea water. After two days of observation, they are put in a cage, suspended on a raft and immersed in the sea. Nacre is secreted and the pearl formation starts.

After about three months, the oysters are taken out of the sea and washed. The shells are opened using a knife and the oysters are laid bare with a slit in their body revealing the unique gems. These are removed gently, washed in a soapy solution and wiped with a silk cloth They are then graded according to size, shape, colour, lustre and quality.

Cultured pearls approximate natural pearls. However, if the covering of nacre is too thin it will deteriorate upon prolonged contact with the acids of the human body, eventually revealing the mother-of-pearl matrix. This happens even with natural pearls if they are not properly taken care of Perfumes, vinegar and other household sprays damage them.

In recent years, there has been an improvement in the quality of cultured pearls. The price of cultured pearls range from Rs. 50 to Rs. 300 per gm which is cheaper as compared to that of the natural pearls which cost Rs. 1,500 to Rs. 2,000 per gm. Newer aspects are being considered in the making of cultured pearls. The latest trend is the culturing of black pearls. Attempts are also being made to manufacture the nucleus industrially. At present, particles of conch shell which can be used as nuclei are collected from Kerala and Tamil Nadu coast.

Production of cultured pearls face a problem of pollution in open seas. This includes fouling by barnacles and parasitic organisms Due to these problems the production of cultured pearls has fallen down. But, with the help of marine scientists we are on our way to develop a pearl-oyster spawning and pearl culture industry.

G. Shaheed

Mr. Shaheed is a correspondent of Mathrubhumi, a Malayalam daily.

User friendly!

THIS book is meant for the beginner who is eager to shake hands with a computer (but is too shy or non-numerate to do so). As the preface indicates, this book is about computing: it is only secondarily a book about computers. It presents almost everything about computing lucidly without assuming prior knowledge of mathematics or electronics from the reader. Even those who have a nodding acquaintance with the computer will find the book handy as it covers an extensive ground and the information is uptodate. The authors assure that if most of the material presented is assimilated one could easily read through many of the computer journals and also be in a position to pick up any programming language from a book.

The book has five parts. The first part, on manipulating symbols, dispels the notion that the computer is only a number cruncher. The various possible applications are traced to the four basic operations—calculating, storing information, communication and control—that essentially computers are capable of. A short introduction to electronics is also included for those who are curious about the principles on which computer components work. Part two presents the development of computers in a historical framework. It explains how the concepts behind computing and the technology of computers themselves have developed. Why digital computers have gained ground over analog computers, the technology that made the modern digital computer possible, the speed and reliability of today's computers have all been briefly discussed.

The book also examines the hardware aspect with two specific examples (The 6502 microprocessor and the minicomputer EMMA). Several aspects of modern computer technology, as varied as memory medium modes of addressing memory, input and output handling devices, the need for standardisation, computer networking are all covered in an easy to understand fashion. The last two chapters deal with programming languages and data structuring and some applications of the larger scale computer systems including artificial intelligence respectively.

A glossary in the end includes words, phrases and alternative spellings that are in common use but not used elsewhere in the book. A selected bibliography is also given for all the chapters.

The book in the best traditions of a well-produced Penguin is a comprehensive introduction to computing by any standards. But take care, the pages might fall off, it is a paperback and not one of these ligature-bound books that seem to defy all attempts at rough handling.

Indira Murthy

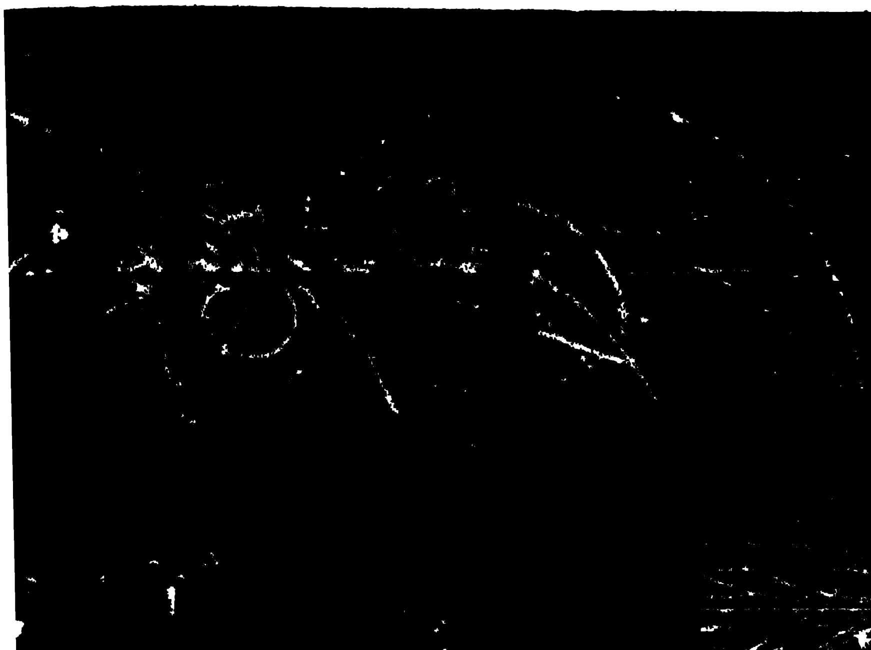
"The Penguin Computing Book, A complete and comprehensive guide to computing" by Susan Curran and Ray Curnow. Penguin Books. £ 5.95

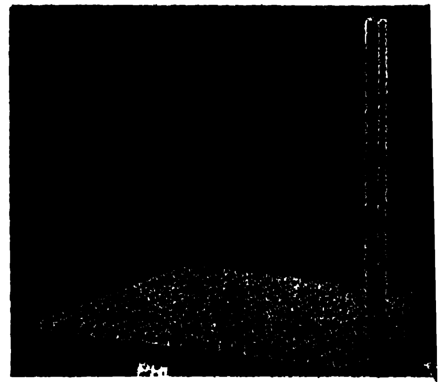
OUR understanding of the basic constituents of matter has changed with time Till the beginning of this century the most basic building blocks of matter were supposed to be the atoms (the word *atomos* in Greek means indivisible). In 1911, Ernest Rutherford, showed that the atom is not an indivisible or elementary object by itself. Instead, it consists of a compact solid nucleus with tiny electrons going around it like a mini solar system. In his classic experiment Rutherford used a beam of charged particles to probe a thin gold foil. It was like shooting a bunch of bullets at a target and studying the pattern of hits on a screen placed on the opposite side. The hit pattern would show whether the target is a compact solid sphere or a hollow one with only a compact solid core. Rutherford found that most of the charged particles passed through the foil straight without deflection. But occasionally one would scatter off the foil at a sharp angle. This showed that it had collided with something small, which was smaller than the individual atoms of gold in the foil. Albert Einstein called Rutherford's technique one of "shooting sparrows in the dark". Yet, despite all our technological progress in high-energy physics, it still remains the principal experimental approach to probe the heart of the atomic nucleus

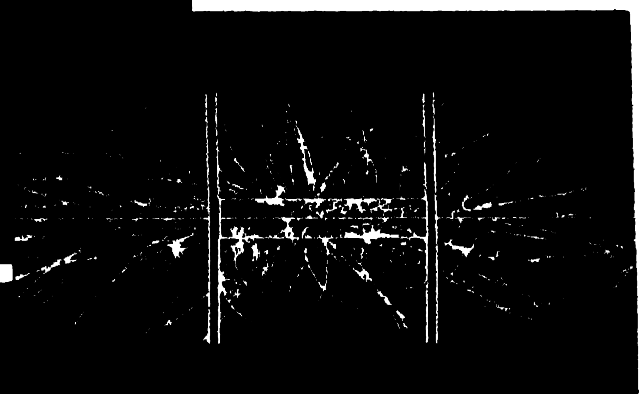
Subsequently the nucleus itself was split into protons and neutrons; and all the 92 atomic nuclei (from hydrogen to uranium) were shown to be built of varying numbers of these two basic objects— jointly called nucleons. While hydrogen is the lightest the heaviest ones like uranium, consisting of 92 protons and an even larger number of neutrons, are known to be unstable (radioactive) – they decay automatically into lighter atoms. In fact, a score of still heavier (than uranium) and more unstable atoms have been artificially produced, which includes the well-known plutonium.

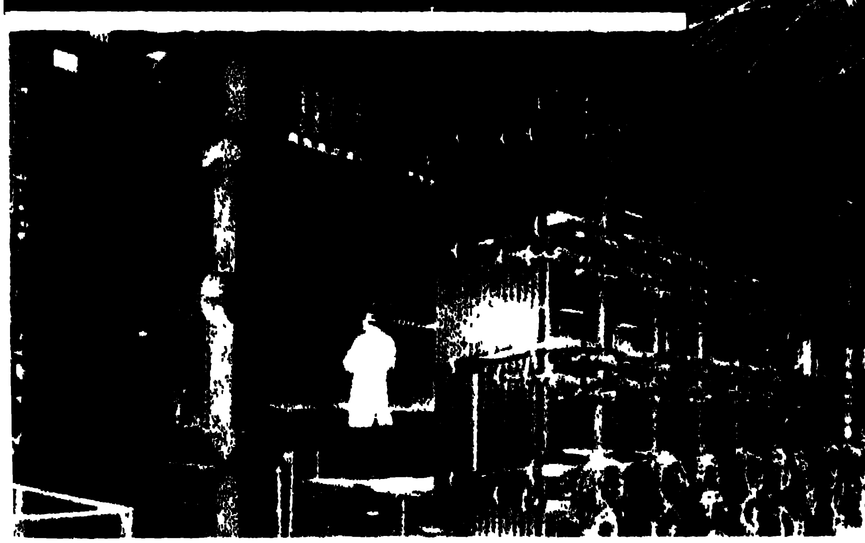
During the last two decades, it has been found further that the protons and neutrons are themselves composed

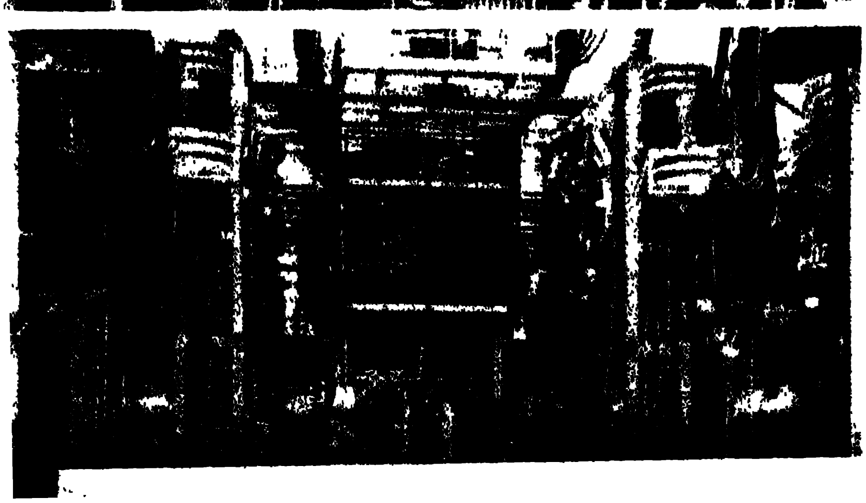
The discovery of W and Z particles in 1983 marks an important milestone on the road to the eventual unification of all the basic natural forces











1. Aerial view of the underground giant particle accelerator in Geneva.
2. Tracks of nuclear particles from a proton antiproton collision disclosed by the central detector of UAI experiment at the European Organisation for Nuclear Research (CERN) Laboratory, Geneva. The display indicates the decay of a particle known as W Boson. According to theory the W and Z particles mediate the weak nuclear force in much the same way that photons carry the electromagnetic force. The strong evidence about the existence of these two "intermediate" particles supports the electroweak theory linking the well-known electromagnetic phenomena—heat, light, electricity and magnetism—with the lesser known radio-active decay. This "marriage" of two forces brings scientists a step near to grand unification of all natural forces.
3. The Boson pyramid
4. A technician inspecting the magnets and calorimeter of the CERN experiment led by Dr Carlo Rubia.
5. The heart of the central detecting chamber

of still smaller entities called quarks. The experiments are similar to the Rutherford scattering experiment, except that the bullets—the charged particles used now—have a lot more energy which enables them to probe still shorter distances.*

According to our present understanding, therefore, the "ultimate" constituents of matter are the quarks and leptons. There are six types of leptons (electron, muon, tau and their associated neutrinos) and as many quarks (up, down, strange, charm, bottom and top). Each set can be organised into three pairs or generations in increasing order of mass, as follows:

leptons			charge	quarks			charge
ν_e	ν_μ	ν_τ	0	u	c	t	2/3
e	μ	τ	−1	d	s	b	−1/3

and similarly for their antiparticles** Each pair represents two charge states differing by 1 unit—charge 0 and -1 for the neutrinos and charged leptons and 2/3 and -1/3 for the u, c, t and d, s, b quarks respectively. In addition, the quarks possess what is called the colour charge. It essentially means that this new type of charge can take three possible directions—rather whimsically labelled red, blue and yellow. However, the nuclear particles, composed of these coloured quarks, have no colour, like the atoms have no net electric charge. This is illustrated above for proton, neutron (both composed of 3 quarks) and the π-meson (composed of a quark-antiquark pair).

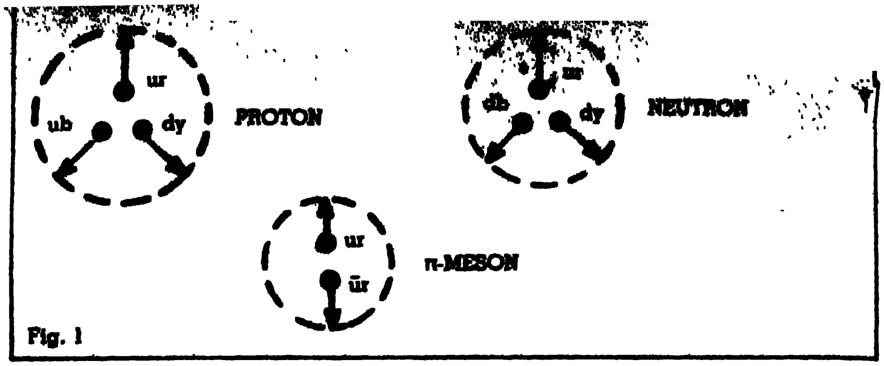


Fig. 1

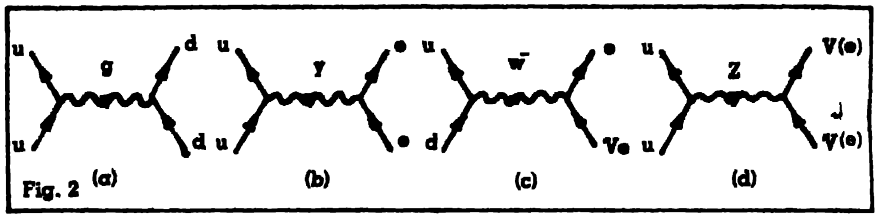


Fig. 2 (a) (b) (c) (d)

Of course, the π-meson is short-lived: the quark-antiquark annihilate on contact. Nonetheless, it is routinely produced in laboratory and is currently tipped for wide usage—from cancer treatment to antimissile warfare.

One notes that the familiar nuclear particles are all composed of the first generation quarks. However, the heavier quark states have been produced in the laboratory and seem to decay readily into the lighter one. They are analogous to the trans uranium atoms described earlier. In fact, one has already observed all the lepton and quark states including the heaviest one (Top quark).

Four types of interactions occur between these basic constituents. Arranged in decreasing order of strength, these are: (1) Strong Interaction: The quarks, carrying colour charge, interact by exchanging mass less particles called gluons (Fig. 2a). This is responsible for holding the quarks together in a nucleon, and also for the nuclear force between the nucleons, which holds them together in an atomic nucleus; (2) Electromagnetic Interaction: All particles carrying electric charge interact by exchanging the massless photon (Fig. 2b). This is responsible for holding the nucleus and the electrons together in an atom; (3) Weak Interaction: It is mediated by the exchange of charged vector Bosons$W^{\pm}$, which couples with the pairs of quarks and leptons listed above (Fig. 2c); and the neutral vector Boson Z**, which couples to every quark and lepton (Fig. 2d). The basic interaction of Fig. 2c is responsible for neutron decay

$$n(ddu) \rightarrow p(udu) + e + \bar{\nu}_e$$

which in turn is responsible for many of the radioactive nuclear decays. (4) Gravitational Interaction: It is mediated by graviton, which couples to all forms of matter. But it is too weak to be of practical interest to our discussion of the subatomic world.

All these carriers of forces are massless, except for the weak vector Bosons, $W^{\pm}$ and Z, which are very heavy. Now, exchange of a particle of mass m means that its rest mass energy $E = mC^2$ (according to Einstein's celebrated equation) is suddenly created at emission and lost at the time of absorption. Thanks to the Uncertainty Principle mentioned earlier, such a temporary nonconservation of energy is allowed, but only over a very short time span $t = h/mc^2$ or equivalently a very short range of distance ($= h/mc$). Thus the weak interaction is a very short range force whereas all the others have long range.

While efforts at unifying the first three forces (Grand unification) and even all the four (Super unification) continue, one has already had demonstrable success in unifying the two intermediate ones, that is, electromagnetic and weak interactions. This is the electroweak theory, for which Glashow, Weinberg and Salam were awarded the Nobel prize in 1980. How does one unify a long range (electro-

**This follows from one of the most fundamental principles of modern physics called Heisenberg's Uncertainty Principle, which States $\Delta x = h/\Delta p$, that is, the uncertainty in distance is inversely proportional to the uncertainty in momentum, with the constant of proportionality given by the Planck's constant ($h \approx 10^{-27}$ erg. sec)*

***Each particle has an antiparticle with same mass but opposite charge, with which it annihilates on contact.*

***Particles with integral and half integral spin, in units of the Planck's constant h, are classified as Boson (after S. N. Bose) and Fermion (after E. Fermi) respectively. All the basic constituents are Fermions; and the carriers of the basic forces are all Bosons.*

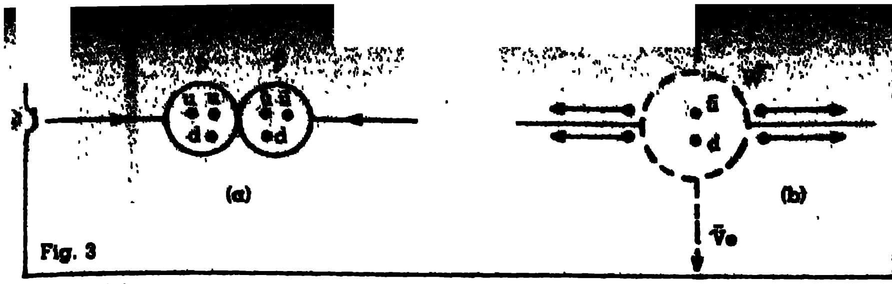


Fig. 3

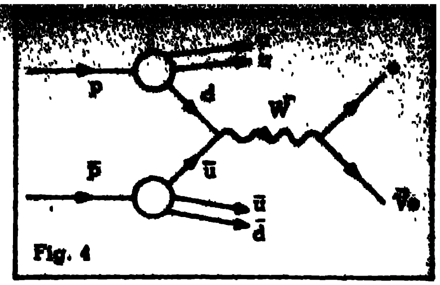


Fig. 4

magnetic) interaction with a short range (weak) interaction, which seem to have, moreover, very different strengths—the two interaction rates differing by a factor of a million at energies of a few GeV?* One does this by connecting up the two anomalous features of the weak vis-a-vis the electromagnetic interaction (short range and apparent weakness) with each other. It is suggested that the inherent strength of the weak interaction is similar to the electromagnetic; and the apparent suppression of the weak interaction rate is a transient phenomenon, which arises because the present interaction energy (E) is very much smaller than the rest mass energy of the interaction carrier ($m_W c^2$). In such a situation, one expects an additional suppression factor of $(E/m_W c^2)^4$. Now, a remarkable prediction of this theory is the mass of the weak vector Bosons. For, a suppression factor of a million at a typical energy (E) of a few GeV, implies a rest mass energy of around a (million) ¼ GeV - i.e. around 30 GeV. More exact calculation gives

$m_W = 82$ GeV/c^2, $m_Z = 92$ GeV/c^2,

that is, the weak vector Bosons are roughly a hundred times heavier than the proton.

The above prediction has had a profound impact on the experimental particle physics. Several particle accelerators have been specifically designed to generate ultra high energy particles to produce these massive Bosons and study their properties The first in line is the proton-antiproton collider machine, built at CERN (Centre Europeenne pour la Recherche Nucleaire), Geneva. It consists of a giant accelerator ring, 6 km in circumference, located in an underground tunnel spanning across the French-Swiss border. In this circular 'Race track' protons and antiprotons are whipped up to an enormous energy of 270 GeV each, and then made to collide head on (Fig. 3a). In a few of these events, a colliding quark-antiquark pair fuse to form a W Boscon (Fig. 3b), converting their huge kinetic energy into the W mass. Of course, it decays instantly, thus converting its huge mass back into kinetic energy of the decay products—often an electron-neutrino pair as indicated in Fig. 3b. In the process it leaves an unmistakable imprint on the decay debris, however. In particular, the electron and the accompanying neutrino carry huge transverse momentum (going upto ½ $m_W c^2$ = 41 GeV each), which no other known mechanism can mimic. Of course, the neutrino escapes detection as it does not have strong or electromagnetic interaction; but its presence can be inferred from momentum conservation, once one sees an isolated electron with large and unmatched transverse momentum.

The rate of such events can be estimated by simply multiplying the rate of the basic weak interaction with the probability distribution of the basic quark (antiquark) constituent in proton (antiproton). This is illustrated in Fig. 4. The estimated rate is about 5 such events in a billion collisions. The rate for the corresponding Z events is 1 in a billion; but it has the advantage that both the decay products (electron and positron, as per fig. 4d) are detectable.

Around the beginning of last year, a team of over a hundred experimenters, led by Carlo Rubbia, reported on their search of a billion $p\bar{p}$ collisions. In deed, they found 5 or 6 events containing an isolated electron with large transverse momentum, which carry a clear imprint of W Boson formation. The finding was shortly confirmed by a second group of experimenters, working at the same accelerator. Both the groups have since extended their research to about ten billion collisions. And they have each found about fifty W events and five Z events. They have also confirmed the theoretical predictions of the W and Z Boson masses, mentioned earlier.

A very important by product of this experiment is a strong hint of the elusive top quark—the last of basic constituents of matter, described earlier. In addition to the 6 isolated electron events (W events), the experimental group of Rubbia reported a dozen of electron plus jet events where a large transverse momentum electron comes back to back with a jet of nuclear particles. It was simultaneously shown by an Indian and an Anglo-American group of theorists that these events can be most naturally explained in terms of top quark production, in the expected mass range of 30-40 GeV/c^2. Moreover, they cannot be accounted for by any other known mechanism, including W and Z production. The significance of the suggestion has been widely recognised by now. One should bear in mind, of course, that the jet plus electron events are more complex compared to the isolated electron events; and besides they have not been experimentally analysed in as much detail. One may quote here a few lines from the News and View columns of *Nature* (7 April 1983): "Theorists in Britain, US and India have independently noticed that the 'electron plus jet' events, suitably interpreted, could indeed be indicative of the top quark's existence with a mass between 25-40 GeV/c^2.... At the very least the theorists have sharpened some of the issues at stake in the search of the top quark; subsequent data might even confirm their proposal. During the next three months, further examples of the 'electron plus jet' events will be looked at as intently as the isolated electron (W) and the $e^+ e^-$ pair (Z). By July 1983 we might have witnessed as many milestones as in the annus mirabile 1932". Detailed experimental analysis of the electron plus jet events is now going on; and where as the time schedule forecast above was evidently too optimistic, a definite picture is expected to emerge in a few months. □

**A GeV (Gega electron Volt) is the energy acquired by an electron in passing through a thousand million volts. This is also roughly equal to the rest mass energies of the proton and neutron.*

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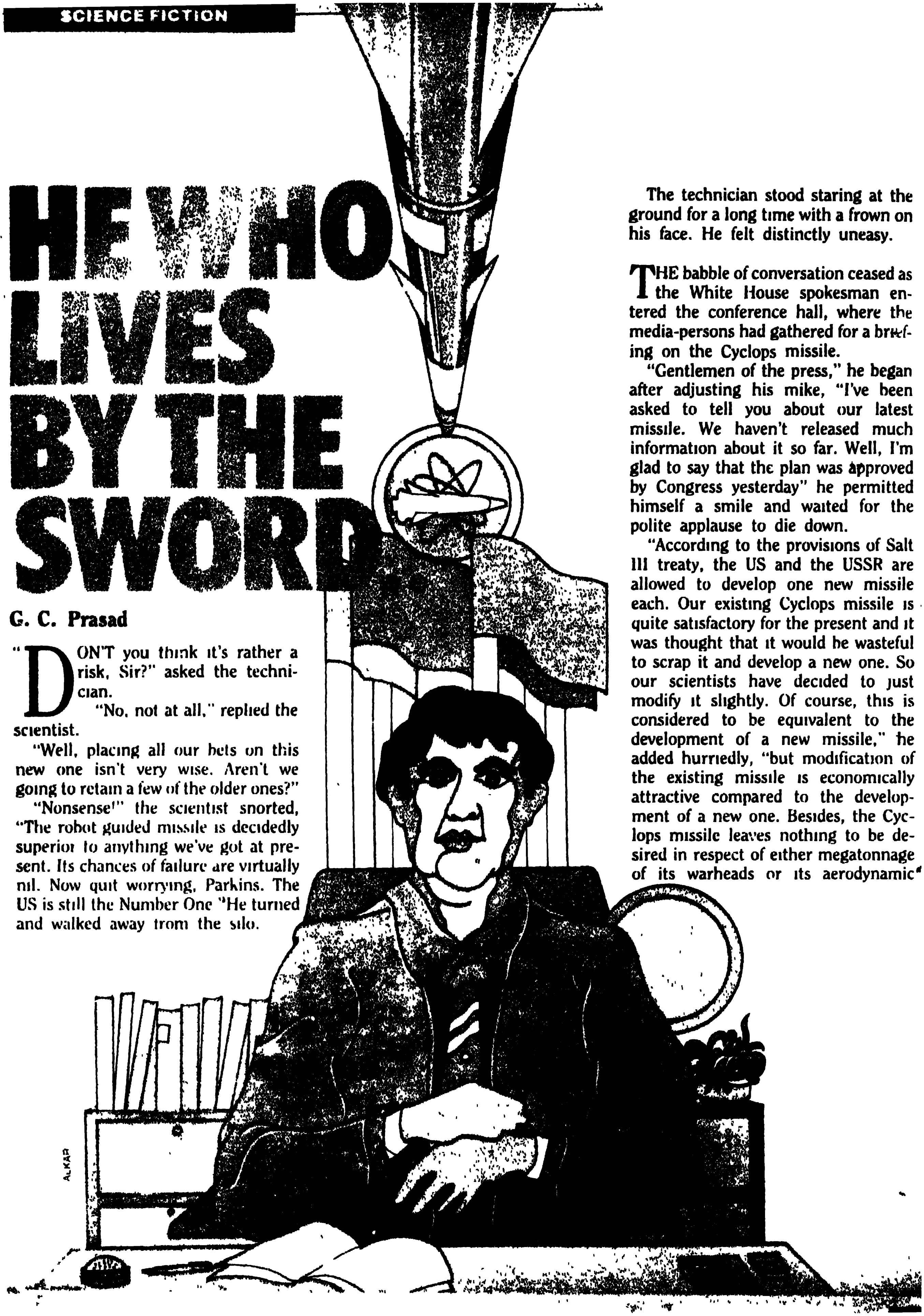
HE WHO LIVES BY THE SWORD



G. C. Prasad

"DON'T you think it's rather a risk, Sir?" asked the technician.

"No, not at all," replied the scientist.

"Well, placing all our bets on this new one isn't very wise. Aren't we going to retain a few of the older ones?"

"Nonsense!" the scientist snorted, "The robot guided missile is decidedly superior to anything we've got at present. Its chances of failure are virtually nil. Now quit worrying, Parkins. The US is still the Number One "He turned and walked away from the silo.

The technician stood staring at the ground for a long time with a frown on his face. He felt distinctly uneasy.

THE babble of conversation ceased as the White House spokesman entered the conference hall, where the media-persons had gathered for a briefing on the Cyclops missile.

"Gentlemen of the press," he began after adjusting his mike, "I've been asked to tell you about our latest missile. We haven't released much information about it so far. Well, I'm glad to say that the plan was approved by Congress yesterday" he permitted himself a smile and waited for the polite applause to die down.

"According to the provisions of Salt III treaty, the US and the USSR are allowed to develop one new missile each. Our existing Cyclops missile is quite satisfactory for the present and it was thought that it would be wasteful to scrap it and develop a new one. So our scientists have decided to just modify it slightly. Of course, this is considered to be equivalent to the development of a new missile," he added hurriedly, "but modification of the existing missile is economically attractive compared to the development of a new one. Besides, the Cyclops missile leaves nothing to be desired in respect of either megatonnage of its warheads or its aerodynamic

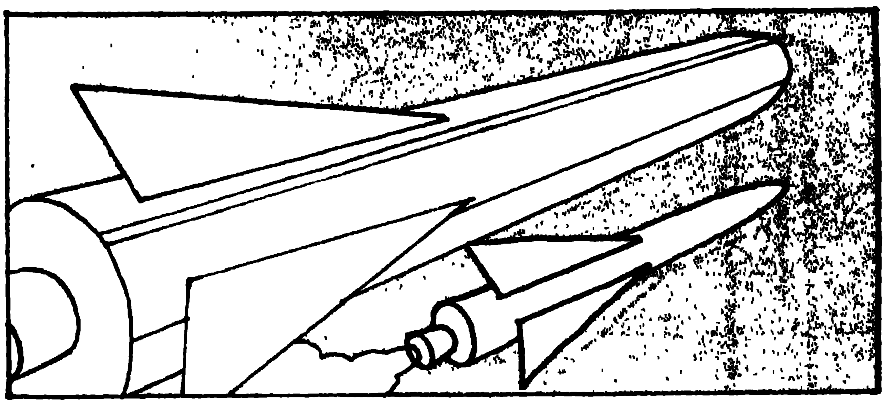
It's all a big chess game. With every move your opponent makes you've to reconsider all your plans...

maneuverability. However, its control systems have immense scope for improvement. It is in the field of cybernetics that our scientists have been concentrating for over a decade. They have recently achieved success in the creation of a robot brain which can be easily incorporated into the existing missile structure."

The man from *The New York Times* raised his hand.

"According to our information, the previous model also carried an onboard computer. Can you explain to us in what respect the robot brain is superior?"

The spokesman paused: "Ah," he



said, "we *do* make a distinction between a computer and a robot brain. But how does a missile of the Cyclops type function? Each missile is programmed to fly to a particular enemy target. Each has an on-board computer with the entire route marked and programmed into it. The missile derives its name from the single camera "eye" with which it keeps track of its course. (Remember the single-eyed monster from Homer's *Odyssey*?) If the missile deviates from the course shown on the programmed map, the computer moves the control surfaces appropriately and brings the missile back on course. It also keeps the missile low to avoid detection by ground radar. If a hill looms up, the camera relays the information to the computer, which makes the missile climb and fly over safely. Once past the hill, the missile returns to tree-top level flight. By constant comparison of the missile's surroundings with the programmed map. the on-board computer can recognise the target when it arrives. Then it causes the warhead to detonate.

"Very good. Now all this describes the missile's working under ideal conditions. There are many reasons why the Cyclops is not cent per cent reliable." He paused and took a sip of water.

"In warfare there are many unknowns", he continued," the missile is not invulnerable to detection and subsequent destruction from the air. Of course, the Cyclops' computer has its own weapons to deal with aerial threats—laser beams to bring down enemy aircraft! But there are other problems, gentlemen. Suppose the enemy aircraft had never spotted the missile in the first place. Then!! The laser burst would give away the missile's presence. The missile should therefore be able to judge whether or not it has been spotted, *before* it takes the offensive. It should be able to draw conclusions from any sudden suspicious action of the enemy aircraft. any sudden banking, diving or even a rapid retreat. Most important. gentlemen, it should be able to intercept radio conversations and understand human speech, a no mean feat. This calls for intelligence, an evolutionary leap from the common or garden variety of the computer to the robot instilled with a silicaceous spirit. And, as I said, war throws up so many unpredictables. and so many schemes have to be discarded along the way. It's all a big chess game. With every move your opponent makes, you will have to reconsider all your plans, even discard them altogether, and decide on fresh ones.

"We cannot predict all the situations the missile may encounter, and hence cannot program its computer to tackle them all. Most of the time, it will have to make decisions on its own".

The spokesman paused to fan himself agitatedly... He took another sip of water and said: "Let's consider a missile flying towards a target in enemy territory, say, an industrial plant. On the way, suppose it spots a nuclear missile being deployed for use against us. Our missile must be in a position to judge whether this enemy missile poses a greater threat to our country than its originally planned target.

'Consider, too, a missile launched in order to hit a military establishment. The establishment has been shifted to a new location without our knowledge. The missile must see through the deception and search for the true location. Now gentlemen you will all agree that all this requires intelligence and judgement, the most human of characteristics. That is where the robot brain comes in" he concluded, "to combine human intelligence, judgement and ability to improvise with the speed and precision of a computer."

"Yes?" he looked towards a bespectacled man who had raised his hand. "You said something about the robot's ability to understand human speech. Could you elaborate on that?"

"Well," the spokesman faltered, "that's really the province of the phoneticians. I've just a rough idea about it myself. Ah, but that reminds me of something very interesting. When our scientists created this brain, they ran into a problem. It was so very human they realised the robot would have to be MOTIVATED to perform its job. In the absence of motivation, it would perhaps be careless about secrecy, and it might not care whether it was detected or not. A disinterested worker is never a very good worker." There was a titter of laughter at this.

"Well,' the spokesman said with a

He'd be inclined to go in for a pre-emptive strike at the Soviets...

trace of embarrassment, "the robot had to be talked to. The robot *had* to receive a political education." Eyebrows shot up at this.

"We had to feed the robot information on Communism and its pervasive evils, the sanctity of human rights, and the way the Communist Governments are oppressing their subjects." "That was enough," he went on, "the robot began to HATE Communism, and its idealistic mind was motivated to destroy it. So you see, once launched, the missile will fly forth with a purpose. It will actively and intelligently avoid obstacles, and ultimately destroy its target, knowing that by this act, it is contributing to the destruction of an evil ideology and the preservation of peace and righteousness." He paused for questions.

The bespectacled man asked again, "Does the robot realise the consequences of detonation? Does it realise the loss of human life it entails?" The spokesman looked embarrassed again! "Well," he said at last, "the robot was merely told that detonation was an act of self-destruction which would contribute to the destruction of Communism."

The *Chicago Tribune* man interrupted, "From what you say, the robot seems to decide its ideological leanings based on ethical considerations. How does it view the concept of self-destruction?"

"It was simple," said the spokesman, "it was told that self-destruction for a higher cause was morally justified."

"All right," said the reporter, "but you said the robot was intelligent. Didn't it occur to it to question how its self-destruction could destroy an ideology?"

The spokesman was very embarrassed now. "I think it was like this," he stammered. "the robot, for all its intelligence, is very childlike and trusting. It has the brain of a new-born baby It believes what it is told, without questioning anything."

"So it accepted your argument along with all its ambiguities?" the reporter persisted.

"Yes."

"And it does not realise that it will destroy humans by its detonation?"

"No."

The reporter had no more questions, but the spokesman noted that he was far from satisfied.

"Will the missile be used for a nuclear first-strike?" the *New York Times* man asked.

The spokesman laughed apologetically. "In accordance with our policy which has remained unchanged since the cold war days," he repeated parrot-like, "the missle is to be used only in retaliation against a Soviet missile attack. However, if our intelligence sources reveal that a Soviet attack is imminent, we will be forced to use the missile in a first-strike to protect our existence."

The conference dispersed in a flurry of papers and a babble of conversation. The spokesman of the White House wiped his forehead with his handkerchief. He heaved a sigh of relief, cautiously.

THE *Chicago Tribune* man felt a gentle tap on his shoulder as the reporters were trooping out of the hall. A grinning, freckled young reporter joined him. "Nice job you did back there," he said, jerking his thumb backwards, "put that fellow in quite a fix."

The *Tribune* man smiled politely but said nothing.

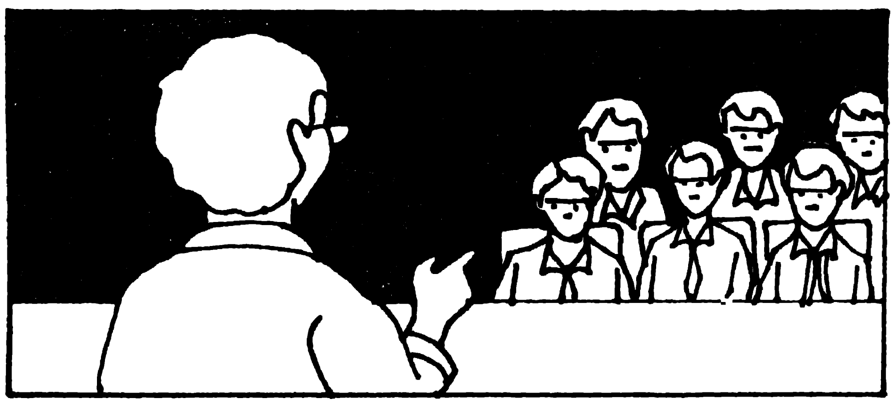
"I'm Al Harris of The *Daily Sun*," said the other.

"The name's Lewis, Jeremy Lewis," said the *Tribune* man, "*Chicago Tribune*. How d'you do?"

They made their way to a cafe on the sidewalk. Harris pulled up chairs and ordered a couple of coffees.

"Well," he began, "d'you think the President is going to retain this missile just for a retaliatory strike, as he claims?"

Lewis shrugged, "I'm not sure. From what I know of President Thornell, he'd be inclined to go in for a pre-emptive strike at the Soviets."



Harris nodded vigorously, "Yeah! And I'll tell you why. It isn't just to avenge the defeat of our troops in Saudi Arabia. We'd always known the Soviets would thrust into West Asia someday and we were prepared for it. Too bad that the war showed up the inferiority of our conventional forces. But Thornell won't strike just to avenge our defeat there."

"I know," said Lewis, "his son was killed in the war."

Harris nodded again, "Andrew Thornell. He was a lieutenant, wasn't he?" They were both silent for a while, then Harris said, "There's another reason why Thornell would like to finish off the Soviets. People have lived with the arms race for more than half-a-century, and they're fed up. The US has to spend billions of dollars on arms every year just because of the Soviets. If they could be written off as a force, Thornell would be able to cut his defence budget considerably and spend more on domestic issues.

"He could bring down prices, cut taxes, improve living standards, oh, a lot of things that appeal to the voting public. He'd be the first President in decades to win a second term. It's too good an opportunity for him to pass up. He could always pretend later on that the Soviets had attacked first. There are many people who are willing to give out false alarms, especially after our Saudi Arabia fiasco. If this missile is as good as it is shown to be, we could hit and not get hit in turn."

"Yes," Lewis nodded slowly, "The main danger of a retaliatory strike from the Soviets comes from their nuclear submarines. But the missile has the capability to break down and destroy even submarines with the help of conventional warheads."

"That capability existed even with the previous Cyclops," Harris pointed out, "and what its daddy could do, Cyclops II can do better, I guess."

"I only hope." said Lewis slowly, "that President Thornell doesn't do anything rash. I wouldn't want this to backfire on us in any way. Remember the saying "He who lives by the sword shall die by the sword'?"

Harris laughed. "Don't worry," he said optimistically, "that missile is the most powerful weapon in the world today. No plane or missile can catch it or destroy it. Don't worry, chum, it'll all turn out okay."

"Perhaps," said Lewis, but he was still uneasy.

PRESIDENT Ernest Thornell hesitated a full moment before picking up the receiver of the special phone and pressing the button.

"Hello, Andrew!" he said.

"Hello, Mr. President," came the metallic voice.

"Ah... how do you feel?" asked the President.

"Well, fine." the voice returned.

"How do you feel about..."

My imminent self-destruction?" asked the robot, "I don't mind at all."

"It is necessary to die, sometimes, for the sake of lofty ideals." Thornell paused, "My son, too, died for those ideals," he said, "you, too, are like my son. That's why I've named you after him." He picked his words carefully, "As we have often told you, great damage is being done to freedom and human rights by the Communist Government of the USSR. Only by the sacrifice of great souls can the world be made safe for democracy. The United States has always upheld the sanctity of life, the importance of human rights, the freedom of speech, of the Press, and all the fundamental rights of individuals."

"I know," came the voice sadly, "I almost don't want to go. I'll be homesick when I leave this wonderful country."

"You've understood whatever we've told you, haven't you?" asked the President quickly.

"A few doubts remain," said the robot frankly, "Ethical questions take time to resolve, even for a robot. But I have made up my mind that I will die for this dear country and all it stands for."

"So you are ready?" asked Thornell.

"Absolutely! We all are, my brothers and I. We have been assigned various places near which we must die: Soviet factories, aerodromes, submarines, yes, we are ready. When you tell us to leave, we will do so."

The President replaced the receiver with a sigh of relief.

The monitoring room was buzzing with activity. The President lifted the microphone, "Andrew, you may now leave on your journey. Good luck and good hunting!" he said.

"Thank you, Mr. President, good bye!" came Andrew's voice. Then the voices of the other robots were heard, too, "Goodbye, goodbye!!"

Missiles emerged from hundreds of silos across the country.

Those with nuclear warheads streaked towards the USSR, across the Atlantic, across the Arctic, across the Bering strait, heading for their targets with wrathful determination. Those with conventional warheads made for the seas, to search for submarines with their uncanny sensory abilities.

"It will all be over within 6 minutes," said a technician to the President. Immediately the loudspeaker crackled to life. "Mr. President," came Andrew's voice, "this is the last time I can speak to you. I wish to tell you that we are gladly going to our deaths for the sake of the country and people you represent. It will be my pleasure to contribute to the destruction of the evil ideology which has brought so much misery to humanity."

There was tense silence for a few moments, then Andrew's voice came again, "Mr. President, we have been conversing, my brothers and I, about this journey of ours. We are all willing to die for the cause of freedom, but we ask ourselves why must it be in the USSR. You yourself told me what a horrible place it was. It IS HELL, and I hate it. You say you consider me your son, Mr. President, I can understand you ordering me to die for this cause, but... father!, why do you wish to send me away from you! I WILL NOT GO TO THAT HELL! I CANNOT!"

"Andrew, what are you saying?" The President yelled. "Go boy! Go!" Cold sweat had broken out on his forehead. "I'm coming back, we're all coming back," said Andrew, "didn't you yourself say self sacrifice for lofty ideals is the greatest thing on earth... Well, we are willing to die, in our country in our native land, by your side, father..." □

Mr. Prasad is studying civil engineering at IIT, Madras. This is his first-ever story to be published

TANTALUM

ILLUSTRATED BY DHANANJAY

IN Greek mythology it is said that once King Tantalus invited the gods to a feast. To please them the king is said to have offered the flesh of his own son. Enraged at this wantonness the gods doomed Tantalus to perpetual torment by thirst, hunger and fear. Ever since, Tantalus is standing in the lower world, up to his chin in water, below the branches of a tree bearing ripe fruits. When he attempts to quench his thirst, the water flows away from his lips. If he raises his hand to get the fruit, the wind blows away the branch out of his reach and added to this an overhanging rock threatens to crush him any moment. The Swedish chemist, Andre Ekeberg, must have been reminded of the agony of Tantalus when he made repeatedly futile attempts to find a solvent for an oxide of a new element he had discovered. His tortuous experience led him to name the element tantalum.

Tantalum found its first commercial use in 1903, nearly a hundred years after its discovery, as a filament in electric lamps. But soon it was replaced by tungsten. Until recently the uses of tantalum were limited. But the situation has changed with a better understanding of the chemistry and metallurgy of this rare element. As a result tantalum has found, today, diverse uses. In electronics industry tantalum capacitors form one fourth of the total production of capacitors. Tantalum based tools are used for cutting steels and special alloys. In chemical industry tantalum assumes many forms: containers for handling highly corrosive chemicals such as sulphuric acid, u-tubes, thermowells, plugs, hardware for vacuum furnaces, flame shields and so on. Since tantalum does not affect the human body adversely, it is found to be an ideal material in surgical implants

The wide ranging uses of tantalum can be traced to its unique properties. It has a high melting point but is very ductile. It does not easily react with many chemicals. It is covered with a film of oxide which is almost impenetrable. Tantalum and its compounds seem to be poised for greater use in the coming years.

Discovery and occurrence

In 1801 Charles Hatchett in England isolated an insoluble and infusable oxide from an unnamed black mineral specimen brought from river Columbia and preserved in the British museum. He named the new element 'columbium'. It was in the following year that Ekeberg isolated an unknown element and named it 'tantalum'. Because of the close similarity in the properties of these two elements they were regarded as the same for over 40 years. In 1844, H. Rose in Germany made an exhaustive study of the black mineral (later named as 'columbite') and showed that it contained at least two metallic elements discovered earlier, in different samples, by Hatchett and Ekeberg. He called one 'tantalum' and the other 'niobium' (Niobe was Tantalus' daughter and the goddess of grief). It was Marignac who developed, in 1966, a chemical method for separating the two closely related elements and adopted Rose's nomenclature; niobium for the lighter and tantalum for the heavier element.

Pure ductile tantalum was produced by Von Bollton only in 1905, for the first time, at Siemen-Halske plant in Berlin. The commercial production of tantalum in the United States commenced in 1922 at Fansteel Metallurgical Corporation by C. W. Balke.

Tantalum ranks fifty-fourth in order of abundance in earths' crust. It is always found associated with niobium. The most important mineral is ferrous manganese tantalate-columbate, (Fe • Mn) $(Ta, Nb)_2 O_6$. If the mineral has more of tantalum pentoxide ($Ta_2 O_5$) than niobium pentoxide, it is called tantalite; if the reverse is true then it is called columbite. These minerals are usually found in pegmatite dikes in quantities which seldom exceed a few pounds per ton. Tantalum is also present in other minerals such as pyrochlore, fergusonite, samarskite and euxenite. These minerals are found in Australia, Brazil, Congo and Mozambique. Tin mineral, Cassierite, is one important source of columbite-tantalite from Congo and Malaya.

In India recent efforts to find an indigenous source has resulted in locating a low-grade columbite-tantalite at Kanigiri district in Andhra

THE HOT AND INERT METAL

H.S. Ahuja

Pradesh, Bastar in Madhya Pradesh and in some parts of Bihar. In Bastar, the tantalite is associated with the tin mineral cassiterite. Similar sources of niobium and tantalum have been identified in Sung Valley in Meghalaya.

The ores are concentrated by hand separation, washing, tabling and electrostatic and electro-magnetic means. The tantalum concentrate reaching the processing plants usually has 60 per cent of combined acids and other impurities such as iron, tin, titanium silicon dioxide and manganese.

Solvent extraction of tantalum

The co-existence of niobium and tantalum in ores and the near similar chemical properties of their compounds requires a fractional method of separating one from the other. There are two methods for separating pure tantalum from the ores.

Fractional crystallisation is the classical method which is based on the differential solubility of the compounds K_2TaF_7 and K_2NbOF_5 in water. This method has been almost completely superseded by the solvent extraction methods in the recent years.

In solvent extraction, the ore is crushed into a fine powder and treated with concentrated hydrofluoric acid to bring the ore into solution. By adjusting the temperature and acid strength niobium and tantalum oxides can be made to dissolve whereas bulk of the impurities remain behind. The liquor containing fluorides of niobium and tantalum is the feed stock for the next stage. This solution is then brought in contact with a water insoluble organic solvent. The organic solvents usually employed are methyl isobutyl ketone (MIBK) and tri butyl phosphate (TBP). Tantalum fluoride alone goes into organic phase at low acidity of the feed stock while at high acidity it is niobium fluoride that does so. The organic layer is then seperated and tantalum fluoride stripped from that phase with deionized water to obtain an extremely pure form of it. The pure aqueous solution is treated with ammonia solution to get tantalum hydroxide which is converted to either high purity Ta_2O_5 or K_2 TaF_7.

The advantages of solvent extraction for the production of pure tantalum are many. The process is rapid, gives high recovery efficiencies and is easier to operate and control.

Processing for the metal

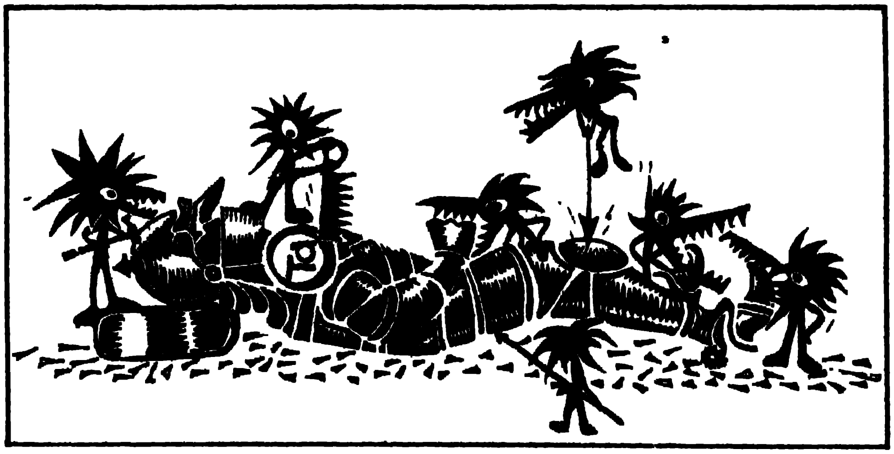
There are several methods for the reduction of tantalum compounds to metal. The processes reported to be in use, industrially, are electrolysis and reduction of pure K_2TaF_7 and the reaction of tantalum oxide and tantalum carbide.

Electrolysis is carried out in open cast iron pots which act as the cathode. Graphite rods suspended in the pot act as anodes. The eleclolyte bath has a solution of K_2TaF_7 mixed with a small amount of Ta_2O_5. The cell is operated at about 900°C when pure tantlum is deposited in the form of crystalline aggregates of small particles. In order to protect the product from air attack at the cell temperature, only 50 per cent of tantalum compound fed to the cell is reduced so that the tantalum metal particles are always surrounded by K_2TaF_7. After cooling at room temperature the cake containing metal powder is ground into a fine powder and washed with water to remove soluble salts. The metal powder thus recovered is washed with strong acids to remove harmful impurities and finally dried. Tantalum powder obtained by this method is usually 99.85 per cent pure. In a variation of this method electrolysis is carried out in a graphite pot which acts as an anode. The cathode is a metal rod, where tantalum is deposited as dendrites.

K_2TaF_7 can also be reduced with a more reactive metal like sodium. This is known as metallothermic reduction:

$$K_2TaF_7 + 5Na \rightarrow Ta + 2KF + 5NaF$$

This is carried out in steel bombs loaded with the two reactants. When the bomb is heated externally, an exothermal reaction proceeds vigorously. This method requires special precaution for safety reasons. After the reaction the bomb is cooled, the recovered material treated with methanol and water to remove excess sodium and other soluble salts. The tantalum powder recovered is washed with acid and dried. The method yields very pure metal powder.



Tantalum is highly resistant to corrosion

A process developed by Balke is based on the reaction of stoichiometric quantities of pure tantalum carbide and oxide

$$5TaC + Ta_2O_5 \rightarrow 7Ta + 5CO$$

The ground carbide is mixed with a requisite amount of oxide. This mixture is made into pellets and fed into a vaccum induction furnace where the reduction takes place. Pellets or roundels of the porous metal are formed as the end product. This is a high temper-

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ature process since both the formation of carbide and the reduction reaction occurs at about 2000°C.

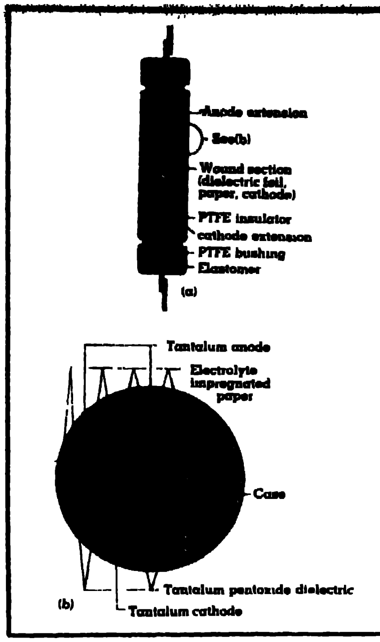
From powder to solid block

The metal powder obtained by the reduction processes can be used directly in some applications. For most other purposes the powder has to be further purified and rendered into a solid form. It is known that very small amounts of oxygen and other impurities greatly affect the properties of tantalum.

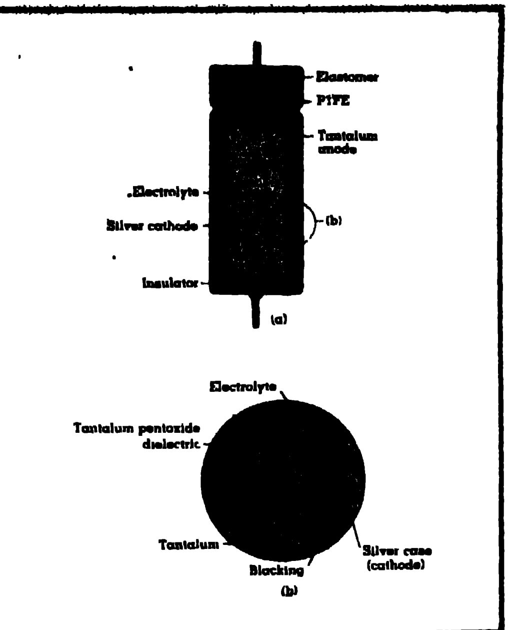
Because of its high melting point (2996°C) the powder cannot be easily melted and solidified. Therefore special techniques are used to convert the powder into a massive form. The methods generally used are sintering, arc melting and electron beam melting.

Sintering: This process consolidates and purifies the metal powder at temperatures well below its melting point. Pressed powder bars are sintered for several hours at temperatures ranging from 2000 to 2400°C in good vacuum. Heating is generally done by induction. Sintering in vacuum removes high vapour pressure impurities like salts and oxides, and low-melting metals; carbon and oxygen contents are reduced through the loss of carbon monoxide. Metal obtained by this method is found suitable for the forming of thin sheets and for drawing into fine wires.

Arc melting: Arc melting technique, widely used in the production of large ingots of refractory metals like titanium and zirconium is applied also to tantalum. Ingots of tantalum as large as 20 to 30 cm in diameter can be made by arc-melting process. In the arc furnace a heavy direct current arc is drawn between a sintered tantalum bar, which is a consumable electrode, and a pad of tantalum metal on the bottom of a water cooled mould. The heat of the arc melts the metal and the molten metal drops into the cooled mould below. A vacuum of the order of 10^{-2}mm Hg is maintained throughout the entire process. During arc-melting the metal is further purified and melting rates of several pounds per hour are normal.



Tantalum foil capacitor



Tantalum wet-electrolyte capacitor

Electron beam melting: This is the latest and the most sophisticated method for consolidation and purification of tantalum metal. In this process a beam of high energy electrons is focussed by an electromagnetic field onto the end of a pre-sintered or pressed tantalum bar. This vacuum melting process effectively removes the gaseous and more volatile impurities contained in the tantalum bar. The vacuum is of the order of 10^{-4}mm Hg. If further purification is required the ingot is remelted in the same furnace.

The metal obtained from this method has the highest purity, excellent ductility and good weldability. This forms the capacitor grade tantalum. Industrially, beam melting has a rate of about 200 pounds per hour.

Chemical properties and compounds

The presence of naturally occurring oxide film on the surface of tantalum makes it inert towards most acids and other reactive chemicals below about 150°C. Substances capable of destroying this oxide film react with the element. The metal is inert to hydrochloric, sulphuric and nitric acids, organic chemicals and several liquid metals. It is slowly attacked by strong alkalies, more readily by fuming sulphuric acid and rapidly by hydrofluoric acid.

Tantalum reacts with oxygen or air to form Ta_2O_5, the reaction begins at 260°C and becomes vigrous at about 800°C. The element reacts with hydrogen above 250°C to form a hydride. All halogens react with tantalum metal to form halides. Carbon and boron react directly to form tantalum carbide, TaC and tantalum boride, TaB_2.

Tantalum pentoxide is the most important compound of tantalum. It is a white powder insoluble in most of the acids and alkalies. Tantalic acid is the hydrated form of tantalum oxide. Tantalic acid forms complexes with several organic polybasic acids which find use in analytical chemistry. Tantalic acid also forms a series of tantalates.

All pentahalides ($TaCl_5$, $TaBr_5$ etc) are covalent and have low melting and boiling points. They also readily hydrolyse when placed in water. The lower valent halides (Ta X_3, Ta X_4) can be prepared by a reduction of pentavalent halides with the metal or aluminium at moderate temperatures.

The organo-metallic chemistry of tantalum is not well developed; however, mixed complexes of cyclopentadienyl and carbon monoxide are known. Tantalum hydride, boride and nitride are some of the well characterized and thoroughly studied compounds of this metal.

Uses

In the recent years tantalum has gained considerable importance in several industries; electronics; high temperature fabrication, chemical and surgical to name a few.

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Tantalum has a very high melting point

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At present the largest use of tantalum is in electrolytic capacitors. It is ideally suited in these capacitors as anode because of the inertness and stability of its electrolytic oxide film. Tantalum capacitor is the standard for reliable performance. Among the three types of construction namely, foil, porous wet anode in aqueous electrolyte and porous anode dry-electrolyte, the last one commonly known as solid electrolyte capacitor (the solid electrolyte being manganese dioxide) has the highest capacitance per unit volume. It operates well in a wide range of temperatures, has excellent leakage properties, good shelf life and long reliable service life. The solid electrolyte capacitors *permit ultimate in miniaturisation.* More than half of tantalum produced is used to make capacitors. During 1981, nearly 600 tons of tantalum was consumed in noncommunist countries to make 3×10^9 individual capacitors

Fabrication of corrosion resistant chemical equipment is the second largest application of tantalum. In addition to being inert to non-alkaline highly corrosive media at ordinary and moderately high temperatures ($\sim150^\circ C$) the metal has an extremely high heat transfer coefficient Since it resembles glass in corrosion resistance, it is often used in conjunction with glass, glass-lined steel and other nonmetallic materials of construction in chemical equipment.

Its typical uses in chemical industry are for heat exchangers, condenser coils, thermometer wells, dip pipes, orifices etc. Tantalum is also used extensively in the repair of flaws and damage in glass lined equipment. Because of its inertness, tantalum equipment finds extensive use in highly corrosive atmospheres such as in the concentration of sulphuric acid, heaters and coolers in chromium plating baths, hydrogen peroxide, and nitric acid heating and concentration etc. It is also used widely in the manufacture of fine chemicals and pharmaceuticals With the availability of large size thin wall metal, the use of tantalum as a liner for reactors, vessels and towers have become feasible

Because of its high melting point, high temperature strength and low vapour pressure it finds use in vacuum tubes as a getter. Tantalum is still favoured as a high temperature heating element. The dielectric oxide film makes the metal a rectifier. This, in fact, was one of the earlier uses and many types of tantalum rectifiers are still being used.

The complete inertness of tantalum to body fluids and tissues has made it attractive as an implant metal for human body in surgical repairs It is used in the form of plates and sheets in bone repairs, as wire for sutures, as foil and wire for nerve repair and as woven gauze for abdominal muscle repair Tantalum metal powder has been used as a focussing aid for the X-ray examination of an excised brain tumor, to monitor its growth. The powder form has also been used for the preparation of bronchograms of the lungs of living dogs.

In nuclear energy system tantalum metal is of interest for handling high temperature liquid metals such as sodium in heat transfer equipment and in containing bismuth uranium alloys.

Among the compounds, tantalum fluoride finds use as a catalyst in rubber industry and the carbide is present in tungsten carbide cutting tools where it imparts shock resistance and a very low coefficient of friction.

The Indian scene

Whereas tantalum finds use in vital non-nuclear fields, its congener, niobium, by virtue of its several attractive metallurgical properties and also low neutron absorption cross section (1.1 barns) is of great interest and importance in future nuclear industry.

In view of this, research and development programme was started at Bhabha Atomic Research Centre, Trombay, several years ago to develop a process for separation, purification and production of these metals from indigenous sources. As a result of these efforts, a plant for the production of tantalum metal was set up at the Special Materials Plant (SMP), Nuclear Fuel Complex of the Department of Atomic Energy at Hyderabad. The commercial scale plant at SMP is engaged in the production of tantalum starting from Indian columbite-tantalite ore. The niobium and tantalum are separated by the solvent extraction using TBP diluted with 50 per cent kerosene. Tantalum recovered as K_2TaF_7 is reduced to metal by sodium reduction, which is consolidated by electron beam melting or sintering technique.

The plant at SMP is presently manufacturing capacitor grade tantalum powder and anodes, high purity rods, wire and sheets of various sizes. In addition, fabricated shapes such as crucibles, boats, furnace parts, cathode assembly etc are made to meet the present demand in the country Tantalum pentoxide suitable for carbide tool industry and potassium tantalum fluoride for use as catalyst in synthetic rubber industry are produced at the SMP to meet our requirements. □

Dr Ahuja joined Bhabha Atomic Research Centre after completing his doctorate at the University of Florida and post doctoral work at the Universite de Montreal His research interests include development of high purity materials for use in electronic industry, organic and organo metallic compounds of Ti, Nb and Ta and most recently of uranium

HEPATITIS: THE YELLOW MENACE

Girish N. Vyas   Hubert E. Blum

HEPATITIS is caused by various drugs, toxins, inherited metabolic disorders and microbial agents that parasitise in the liver. Abnormal liver function tests, especially alanine aminotransferase (ALT or SGPT, enzymes present in the blood serum) elevations, are the principal indicators of liver disease. Thus. primary infection of the liver caused by the hepatitis A virus (HAV) and the hepatitis B virus (HBV) is recognised by sensitive and specific testing of the blood serum (serology). ALT elevation with absence of HAV and HBV in serum and exclusion of nonviral causes of liver injury, e.g. drugs or alcohol lead to recognition of hepatitis due to the non-A, non-B agents. Specific serologic assays for the agents causing non-A, non-B (NANB) hepatitis are unavailable at present, yet clinical evidence for more than one transmissible agent causing NANB hepatitis has been established by serial transmission in man and chimpanzees. Besides these three types of viral hepatitis, hepatitis also occurs as part of a more generalised illness secondary to infection by viruses such as cytomegalovirus, epstein-bar virus, herpes simplex virus, varicella zoster virus, coxsackie virus, rubella virus, etc.

The contagious nature of agents involved in epidemics of jaundice has been recognised from ancient times. The term viral hepatitis type A or simply hepatitis A (HA) is synonymous with the diseases described as infectious hepatitis, acute catarrhal jaundice or epidemic jaundice. Infection caused by HAV has worldwide distribution and occurs commonly in children and young adults in poor hygienic conditions

Viral hepatitis type B or hepatitis B HB) commonly called serum hepatitis is synonymous with transfusion jaundice, syringe jaundice or post-vaccinal jaundice. Several historic outbreaks, occurring during mass vaccinations, in venereal disease clinics, in diabetes clinics and in patients transfused with pooled plasma. are attributable to contamination with HBV. The current epidemic of jaundice in Gujarat, especially in Ahmedabad is due to HBV.

Clinical signs and symptoms

Hepatitis virus infections are asymptomatic in a vast majority of patients, especially in children. One cannot recognise them unless they occur as a part of an outbreak of icteric (jaundice) cases and they may be detected only when ALT levels are elevated. Infections also occur in both HA and HB without any laboratory evidence of liver inflammation.

Symptoms in the early phase of jaundice are often mild and may be only non-specific manifestations of generalised viral infections such as low-grade fever (usually less than 38°C), malaise, fatigue, anorexia, nausea and vomiting. A frequent first symptom is a type of (urticarial) skin rash. Infantile papular acrodermatitis, a fine erythematous papular rash found primarily on the head, neck, arms and legs, has also been described among infants with HBV infection. Unusual manifestations of infections are glomerulonephritis and polyarteritis, both considered secondary to immune-complex formation.

Jaundice will be apparent in more severe hepatitis, usually first noted as scleral icterus in which the whites of the eyes turn yellow. This happens when serum bilirubin levels reach 2.5 to 3.5mg/100 ml, urine becomes dark brown in colour due to the excess excretion of bilirubin. Decreased bile excretion is manifested by pale, sometimes fatty stools.

Although extremely rare in infants and children, severe (fulminant) hepatitis with coma can develop in young adults. Impending coma should be suspected when changes in level of consciousness, drowsiness or irritability occur.

Pathogenesis

Current evidence suggests that neither HAV nor HBV cause abnormalities within cells that is they are not directly cytopathic. Entry of the virus

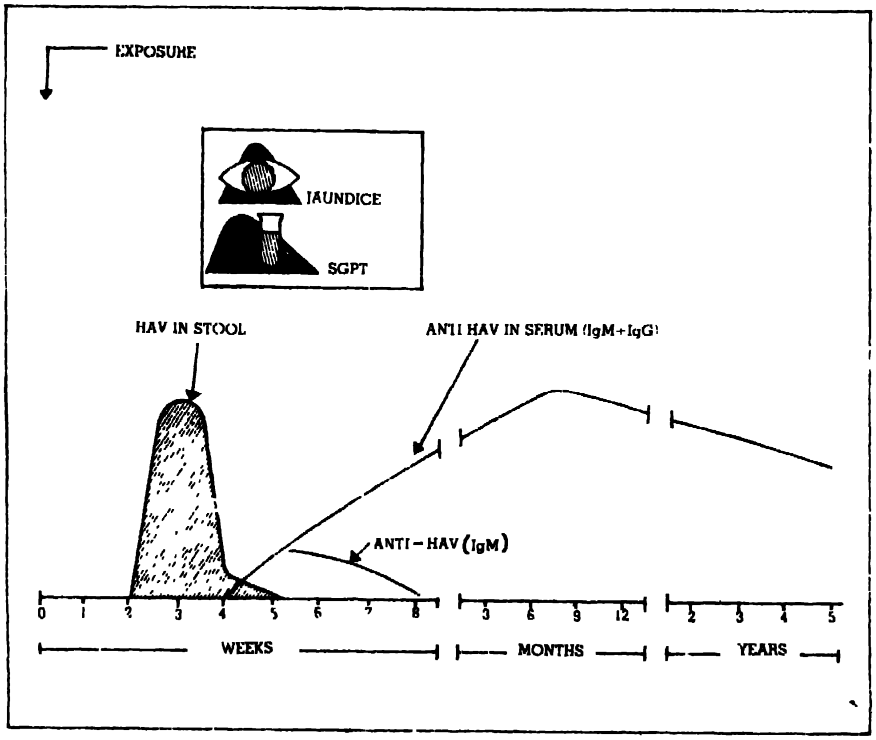


Fig. 1 Temporal changes in the clinical and laboratory findings in acute HAV infection

into the liver cells or hepatocytes appears to be dictated by receptors specific for the viral coat. The immune response to liver-specific proteins, polymerised serum albumin or to viral antigens on the cell surface presumably causes the damage to liver cells. In vitro assays of cell-mediated immunity to antigenic components of HBV suggest that the cellular immune responses (SCIENCE TODAY, May 1980, p. 50) may contribute to pathogenesis of liver disease. However, the precise immunological mechanisms of liver injury in viral hepatitis are not defined adequately; indeed, they remain largely speculative and controversial. In contrast, the manifestations of hepatitis B occurring outside the liver such as urticaria, glomerulonephritis and polyarteritis are clearly attributable to immune-complex phenomena.

[illegible] is produced from the breakdown of haemoglobin in blood in the reticuloendothelial system. This is a macrophage system including all phagocytic cells of the liver, spleen and bone marrow. The function of phagocytic cells is to engulf and breakdown the worn out or diseased red blood cells in the body. Now, bilirubin when produced in normal amounts is discharged into the blood and excreted by the liver. If the rate of bilirubin excretion is not proportional to the rate of production, it accumulates in the serum thereby staining tissues giving rise to visible symptoms of jaundice.

Clinically, there are three types of jaundice—pre-hepatic (haemolytic), post-hepatic (obstructive) and hepatic (hepatocellular). All these types are concerned with the production and excretion of bilirubin.

In pre-hepatic jaundice the production rate of bilirubin is very high but the [illegible] excretion of bilirubin. [illegible] production of bilirubin [illegible] breakdown of haemoglobin, causing haemolytic anaemias and neonatal jaundice as characteristic of newborns.

A mechanical obstruction of bile in the biliary transport chain is the cause of post-hepatic or obstructive jaundice. Normally, bile flows from the gall bladder into the duodenum through the bile duct. The obstruction may occur either due to a tumour of pancreas which compresses the passage of the biliary tract (bile duct) or due to the presence of a stone in the bile duct. This impedes the normal flow of bile. In serious situations, bile 'back flows' into the circulation and excess bile pigment in the serum produces the signs of jaundice.

The third type—hepatic jaundice is caused by bacteria, viruses, protozoa or toxic action of drugs such as alcohol, chloroform etc. All these cause inflammation and damage the liver cells leading to diminished liver function and decreased excretion of bilirubin.

Parul R. Sheth

Markers of infection

Early studies with human volunteers established the existence of two unrelated viral hepatitis agents, HAV (RNA virus) and HBV (DNA virus). Subsequent transmission of HAV to marmoset monkeys and of HBV to chimpanzees provided the experimental models for infection. Through biochemical, electronmicroscopic and serologic studies a detailed characterisation of both HAV and HBV has been achieved. The agents of non-A, non-B hepatitis remain undefined except for the successful and serial transmission of non-A, non-B hepatitis from man to chimpanzees and from chimpanzees to chimpanzees. A variety of immunological assays are available for specific markers of hepatitis A and B viruses. Detection of hepatitis B antigen on the viral surface (HBsAg) in the serum is the principal diagnostic test for HBV infection. Hemagglutination assays (HA) are relatively simple and inexpensive. In these, the presence of HBsAg in serum is detected by the ability of the serum to agglutinate sheep red blood cells coated with the corresponding antibody. But these are marginally less sensitive than the enzyme-linked immunosorbent antibody (ELISA) techniques and radioimmunoassays (RIA). The ELISA or RIA procedures are most commonly used in the USA, while HA is commonly used in England and Japan.

Hepatitis A virus infection

The HAV is a typical enterovirus (virus which thrives in the gastrointestinal tract). Preceding clinical onset, a large amount of HAV is excreted in the stool (Fig. 1). This type of hepatitis is common in early childhood, especially in tropical countries where personal and public hygiene is conducive to its spread, predominantly through contaminated water, food and utensils. Fortunately, HAV infection has no chronic sequelae and it confers lifelong immunity. Acute onset of clinical symptoms is followed by jaundice lasting for two to three weeks. Loss of appetite, deep yellow urine, rash and flu-like symptoms are common. Laboratory test for IgM antibodies (a class of immunoglobulin possessing antibody activity) to HAV establishes the diagnosis in acute phase; later the anti-HAV is of IgM class and indicative of immunity. Epidemics of hepatitis reported from Kashmir appear to be like HAV in its pattern but it has been serologically classified as another NANB hepatitis without chronic sequelae.

Hepatitis B virus infection

The 1963 discovery of Australia antigen by Baruch Blumberg, the Nobel Laureate from the University of Pennsylvania, opened an exciting chapter in the history of medicine. The antigen is now established as hepatitis B surface antigen (HBsAg) whose immunochemical structure has been a subject of research interest since 1969. The high level of the nucleic acid-free envelope protein occurring as 22nm (10^{-9}m) particles in the plasma of infected individuals permits serological detection of HBsAg. Such individuals are called chronic carriers (estimated to be 200 million in the world). Serum HBsAg is an indicator of HBV infectivity. However, sera and blood products can be infectious despite being HBsAg negative by radioimmunoassay as evidenced by the five to ten per cent incidence of HBV infection in post-transfusion hepatitis. Furthermore, HBsAg positive, HBeAg-positive (an antigen accompanied by HBsAg which is an early indicator of acute active infection) specimens are over 30,000 times more infectious

than HBsAg positive, HBeAg negative sera, that is HBeAg indicates high infectivity.

The HBV infection is a major public health problem because it causes a spectrum of acute and chronic liver disease (CLD) including liver cancer or hepatocellular carcinoma (HCC). In fact 90 to 95 per cent of adults infected by HBV become immune but five to ten per cent become chronic carriers. The course of acute HBV infection and its chronic sequelae are diagramatically presented in Fig. 2. Acute HBV infection during pregnancy transmits HBV infection from mother to babies. The risk of perinatal transmission of HBV to a baby is 95 per cent when the mother is HBeAg positive carrier of HBsAg. Such babies almost always become long term carriers and are at a risk of developing CLD and HCC.

Chronic HBV infection

The natural history of hepatitis B is varied and complex. Three forms of HBV infections are encountered in clinical practice: acute hepatitis B, inapparent sporadic episodes of unknown origin, and the apparently healthy chronic carriers detected by the screening of HBsAg. Perinatal transmission of HBV infection, especially from the HBeAg-positive mother to newborn, leads to indefinite persistence of the infection in about 85 to 95 per cent of the infants. In contrast, only ten per cent of the individuals with primary infection later in life remain persistently infected. Immune complexes containing HBsAg and IgM persisting in about seven per cent of the patients with acute hepatitis B has been reported to be a predictor of chronicity.

Chronic HBV infection is characterised by high levels of HBsAg, HBeAg, anti-HBc (antibody to hepatitis B core antigen), DNA polymerase and varying elevations of ALT reflecting active virus replication and liver disease activity. Seroconversion from HBeAg to anti-HBe in chronic carriers is often preceded by acute exacerbation of chronic hepatitis. Thus, chronic carriers of HBV do not present as two separate forms—disease

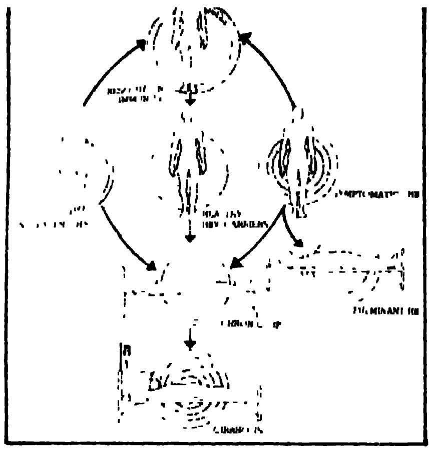


Fig. 2 Different outcomes of infection

and "healthy" carrier state; rather, there are two stages of chronic HBV infection: 1. An early phase of one to 20 years during which hepatitis disease activity may be present with HBeAg in the serum, and 2. A later stage when necroinflammatory activity ceases and seroconversion to anti-HBe occurs.

The so-called "healthy" carriers are most frequently detected by screening blood donors and health care workers for HBsAg. The natural history of liver disease in asymptomatic carriers has been investigated in several studies. Despite qualitative and quantitative differences, these studies have revealed subclinical forms of liver disease with abnormal liver function tests, HBeAg and a spectrum of tissue (histologic) abnormalities. More males than females, more young adults than older people, and more Orientals than Caucasians have chronic carrier state without apparent liver disease. Among chronic carriers a seroconversion from HBeAg to anti-HBe occurs progressively with age.

A spontaneous clearance of HBsAg has been noted annually in about one to two per cent of the chronic carriers. Because the carriers have a greater susceptibility to the hepatotoxic effect of alcohol and the evidence of high HBV infection rate is recorded in alcoholic cirrhosis and HCC, it may be advisable for chronic carriers to abstain from consumption of alcohol. Chronic HBV infection appears to be a dominant cause of CLD, classified as a variety of distinct disease states associated with characteristic histologic expression, e.g., degrees of portal inflammation, chronic persistent hepatitis, chronic active hepatitis with/without cirrhosis, fatty liver with large cytoplasmic fat globules. The natural course of HBsAg-positive chronic active hepatitis is progressive with frequent evolution to cirrhosis, HCC and death due to liver failure or bleeding oesophageal varices. Use of corticosteroids certainly has no value in the treatment of HBV-related chronic active hepatitis; in contrast, autoimmune hepatitis may respond favourably to steroid therapy.

Delta agent in chronic HBV infection

The studies by Rizzetto and colleagues have established the clinical importance of the delta agent which requires HBV as a covirus. The chronic carriers of HBV may have a superimposed acute delta infection which is generally detected by serologic test for anti-delta in the serum. The delta agent is a small molecular weight RNA agent transmissible to HBV-infected humans and chimpanzees. It is generally undetectable in the serum but it is detectable in the nuclei of hepatocytes by means of fluorescent anti-delta antibodies. When superimposed on the chronic carrier state, delta infection tends to be chronic with marked persistence of IgM anti-delta in the serum. The morbidity and mortality of delta infection is remarkably high. Although originally described in drug addicts in Italy, the delta infection occurs worldwide. Apparently the patients with chronic active hepatitis and chronic delta infection have a remarkably progressive course. In a recent epidemic of delta infection in chronic HBV carriers in Venezuela, an alarmingly high mortality rate has been noted. Although the drug addicts are a principal reservoir of delta infection, male homosexuals and other chronic carriers of HBV are at an increased risk of developing delta-associated chronic active hepatitis.

The current epidemic of hepatitis in physicians and nurses in several hospitals of Gujarat is reportedly due to HBV infection. Only 25 per cent of the infected persons have acute liver disease and 1 per cent have fulminant hepatitis B with 80 to 90 per cent mortality. There is no treatment for hepatitis B but it can be prevented by HBsAg vaccine.

A special article on hepatitis scourge in Gujarat by an internationally renowned scientist

Vaccine for hepatitis B

IT is known that all diseases caused by [illegible] have no therapeutic regimen. [illegible] falls in the same category. Hence, rest and a diet rich in carbohydrates, vitamins and proteins is recommended. Prevention of the disease is the only solution. Fifteen years ago prevention was impossible. Now, there is a protective vaccine.

Vaccines can be of three types—a vaccine made from inactivated pathogens (disease causing microbes), or live attenuated (weakened) pathogens. The third type consists not of whole microbes but of modified toxic substances which are chemically treated—toxoids. When injected, the vaccine works by stimulating the disease without any ill effects. It alerts the body to defend itself by generating an immune response leading to the formation of antibodies to that vaccine. These antibodies are capable of fighting against the pathogens.

It was a difficult task to develop a vaccine against hepatitis B. In the preparation of any vaccine, vast quantities of pathogens are required. Other pathogens which cause diseases like polio or measles can be grown in cultures albeit with some difficulties. Therefore, the blood from a hepatitis-carrier had to be collected. The serum containing the viruses was boiled or chemically treated to inactivate the viruses. Even after inactivation the virus still retained the antigenic property to stimulate antibodies production against itself in a patient suffering from hepatitis B. This was the beginning of the wonder vaccine for HBV. The groundwork for active immunisation against hepatitis B was laid by Krugman and his colleagues in the USA between 1970 and 1973. When the boiled serum was administered to susceptible subjects, the material served as a vaccine. The vaccine either protected the subjects from infection or ameliorated the illness in most recipients who were subsequently challenged with HBV.

Several research teams then tried to improve upon this method. Ultracentrifugation (high-speed spinning) of the serum resulted in the highest yield and the purest product. Further, to eliminate any residual live HBV, inactivation was done using formalin. Subsequently, the serum was treated with a series of chemical compounds known to inactivate a variety of viruses affecting human beings and also to eliminate residual traces of serum proteins.

Once the HBV vaccines were ready, they were tested for safety and immunogenecity in chimpanzees. The vaccine still required minor modifications. Finally, Wolf Szmuness, a clinician at the New York Blood Center, USA, and his co-workers carried out the first clinical trial of an HBV vaccine in humans. This was published in a report in *The New England Journal of Medicine*, (303, 15).

During the clinical trials, out of 1,083 people who received the first injection, 1,040 (96.5 per cent) showed up for the second shot. What no one had anticipated was just how well the vaccine would perform. The efficacy of the vaccine protecting the people against infection was 81 per cent and the vaccine was 92.3 per cent effective in protecting high-risk individuals. No clinical trial had ever before achieved such remarkable results. Moreover, the adverse effects (sore-arm in 15.8 per cent of the subjects and low-grade fever in 2.5 per cent) were negligible, especially as compared to the 27 per cent incidence of HBV infections in unvaccinated controls.

The vaccine's efficacy was obvious within the first 10 weeks. Szmuness's study also showed that the immune response generated against HBV declined after nine months in recipients of the vaccine. However, it was intriguing that four per cent of the vaccinees did not acquire immunity to HBV and remained as vulnerable to infection as the placebo recipients.

Another question which is not yet resolved is whether successful immunisation with HBV vaccine of one sub-type will confer immunity against infection with HBV of other sub-types. In relation to these sub-types, experiments were carried out in chimpanzees. On the basis of these experimental results and the observations in human beings, using HBV vaccine such cross-protection against the disease is expected. However, vaccine from Merck Institute for Therapeutic research has proved effective.

With the availability of a successful vaccine for hepatitis B in a bold move, the WHO recently announced plans for an extraordinary experiment in China to see if the hepatitis vaccine will prevent a lethal form of liver cancer prevalent there—the first test ever of a cancer vaccine. The evidence that hepatitis B causes liver cancer is so strong that experts predict that by preventing hepatitis, the vaccine could also prevent about 95 per cent of the cancer.

P.R.S.

Prevention of hepatitis B

The protective effect of anti HBs against infection by HBV has led to the use of a vaccine consisting of the 22 nm particles of viral envelope protein isolated from the plasma of HBsAg carriers. A large body of data on clinical trials, safety and efficacy of the HBsAg vaccines has been published. In the United States a safe and effective vaccine produced by Merck, Sharp & Dohme (MSD), Heptavax-B, has been licensed for clinical use. Similarly, in Europe vaccines made by Pasteur Production of France, as well as MSD, have been licensed. Both these vaccines utilise highly purified HBsAg following inactivation with formalin and alum as adjuvant (material that enhances the action of antigene). The Central Laboratory of the Netherlands Red Cross (CLRC) employed a different process of purification of HBsAg with heat inactivation at 101°C for 90 seconds and the final product heated at 65°C for 11 hours. This vaccine is also safe and effective in the clinical trials recently reported at the WHO Symposium in Athens (November 15 to 18, 1982). Thus, MSD Pasteur and CLRC vaccines

containing 20, 5 and 3 micrograms of HBsAg per dose, respectively, are highly immunogenic, safe and effective in providing sustained protection against a serious infection causing acute and chronic liver disease. Although long-term follow-up is not available, most of the vaccines have elicited anti-HBs response sustained for as long as three years. Several of the early vaccinees have shown protection and anti-HBs for more than five years. Most importantly, HBsAg of one sub-type used in the vaccine is protective against HBV infection of other serotypes.

Intramuscular injections of the vaccine are given in three doses over a period of six months. Following the first dose, more than 50 per cent of the vaccinees produce serologic evidence of anti-HBs response. The second dose of the vaccine is given one to two months later, and a third dose is administered six months after the primary immunisation. After completion of the course of three doses, more than 95 per cent of the individuals are successfully immunised. The nonresponders or the hyporesponders may be given a second set of injections. At the present time there is no recommendation for the management of nonresponders. It must be emphasised that the inactivation procedures have been shown to destroy infectivity of all the viruses tested so far, giving us a strong assurance that no transmissible agent possibly present in human plasma could escape these inactivation procedures. Most importantly, there is no evidence whatsoever to suggest that the trans missible agent(s) of the so called acquired immune deficiency syndrome (AIDS) escape the inactivation procedures employed in producing the vaccine. □

Dr Vyas is Professor of Laboratory Medicine and Chief, Transfusion Service, University of California, San Francisco, USA. He has been a leading research scientist in the field of hepatitis and has made significant contribution to the understanding of the molecular biology of hepatitis virus

Dr Blum is a visiting Assistant Professor from the University of Freiburg, West Germany. He is a recipient of the Heisenberg Award of the Deutsche Forschungsgemeinschaft

Structure and molecular biology of HBV

THE hepatitis B virion (Dane particle) contains HBcAg (hepatitis B core antigen), HBeAg, a partially double-stranded DNA of about 3.2 kilobase with a covalently attached protein, a DNA polymerase and protein kinase activity within the core that is fully enveloped by HBsAg (Fig. 3). Because of the DNA

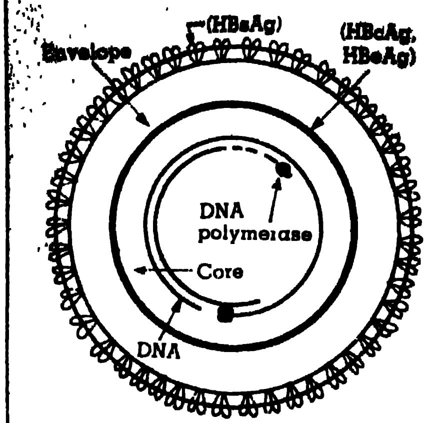


Fig. 3 Hepatitis B virion

homology, polypeptide similarities and antigenic crossreactivity between HBV and other distinct hepatotropic viruses found in the woodchucks (WHV), ground squirrels (CSHV) and Pekin ducks (DHBV), these agents are termed Hepadna viruses (hepatotropic DNA viruses). Entry of HBV in the human hepatocytes is apparently mediated by a receptor specific for the HBV-envelope protein. Despite the failures to grow normal human hepatocytes in culture and to propagate HBV in vitro, a remarkable understanding of the hepatocellular replication of HBV has been acquired indirectly. During the entry into the hepatocytes, the HBV DNA must be uncoated and processed through a series of replicative steps (Fig. 4). It appears that HBV is a unique DNA virus that replicates like the retroviral family of RNA viruses.

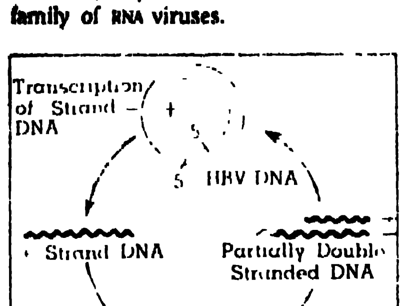


Fig. 4 A simplified model of HBV replication. Replication of DNA takes place through the reverse transcription of an RNA intermediate (retrovirus)

Whereas HBV is transmissible only to humans and chimpanzees, the genetic analyses of cloned DNA of various Hepadna viruses have revealed a remarkable degree of phylogenetic relationship. For example, the complete nucleotide sequence of HBV, DHBV and WHV DNA revealed striking similarities with the highest degree of homology in the gene encoding the core protein. Accumulating epidemiologic evidence indicates that viruses genetically related to HBV, but antigenically distinct, may be responsible for some cases of NANB post-transfusion hepatitis and chronic liver disease.

The restriction endonuclease analyses of cloned HBV DNA have revealed genetic similarities between several of the Hepadna viruses. A single EcoRI site, common in various Hepadna viruses, is used as a reference point in the genetic map of HBV (Fig. 5). Complete nucleotide sequencing of cloned DNA of HBV, DHBV and WHV have been performed by several investigators. The genes C and S encoding the core and the envelope proteins of HBV respectively have been localised and

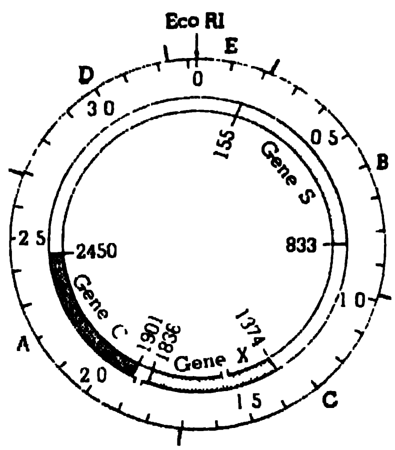


Fig. 5 Genetic organisation of an HBV genome with a single Eco RI site used as a point of reference

the segment encoding the major antigenic determinants a and d/y has been localised in the middle of gene S. The polymerase gene and an undefined gene X, potentially capable of coding for a protein, are hypothetical propositions. A remarkable similarity in the molecular biology of phylogenetically separate HBV, DHBV and CSHV is illustrated by the occurrence of asymmetric replicative intermediate forms of viral DNA in human liver duck liver and ground squirrel liver, respectively.

G.N.V.
H.E.B.

How much do 'eu' know?

Gillian Valladares

WORDS beginning in 'eu' have been chosen for this month's quiz. 'Eu' is a prefix derived from the Greek words *eus* and *eu* meaning "good" and "well" respectively. Eu is the symbol for the element Europium and e.u. is a unit in thermodynamics, for entropy. Eulerian and Euclidean refer to the mathematicians Euler and Euclid respectively. The prefix 'eury' is a form of the Greek *eurys* meaning "broad" or "wide". *Eurus*, the ancient Greek personification of the east and southeast wind has also inspired a few words. The meanings of the words chosen for this month's quiz, lie in their etymological roots. 'Eu' guess what they are. Answers on pg 75 and 76.

(1) Euchromatin:
(A) An emerald-green mineral
(B) A chromosome part
(C) A subclass of the mosses

(2) Eugenics:
(A) Managing environmental conditions to improve mankind
(B) Managing the developmental patterns of individual humans
(C) Practices to improve mankind genetically

(3) Eustacy:
(A) World wide fluctuations of sea level
(B) A cartilage-bone tube connecting the nose, throat and ear
(c) Normal childbirth

(4) Europa:
(A) A fungus disease of fruit and shade trees
(B) A Greek muse
(C) A satellite of Jupiter

(5) Eurygamous:
(A) Mating in flight
(B) A cell with a definitive nucleus
(C) Animals with true body cavities

(6) Eurypterids:
(A) An aromatic spicy liquid extracted from clove oil
(B) A subclass of fossil arthropods
(C) Having a body with a constant cell number

(7) Euthanasia:
(A) Mercy killing
(B) An instrument to measure volume changes during gas combustion
(C) Organisms living at the bottom of a water body

(8) Euglena:
(A) Having a broad, thickset body build
(B) A genus of water lilies
(C) A genus of microscopic green organisms

(9) Eutectic:
(A) An alloy of greatest fusibility
(B) An ideal human society where people are perfectly content
(C) Banded igneous rocks

(10) Eudyptula:
(A) A meteorite component
(B) Chipmunk
(C) Penguin

BRAIN TEASER

Necklaces

GIVEN plenty of black and red beads, how many different kinds of seven bead necklaces can you weave?

For each number of black beads (less than or equal to 7) consider the several ways of positioning the remaining number of red beads.

(Solution next month) **A. R. Rao**

Mr Rao is with the Vikram A Sarabhai Community Science Centre Navrangpura, Ahmedabad

Solution to July teaser

Who is engaged to whom?

From 1 and 2 we see that Kalyani is not a teacher and Monica is also not a teacher. So Rajni is the teacher

From 3 Kalyani is not a writer. So she is the clerk Hence Monica is the writer

From 1 and 3 we find that Monica is engaged to Tarun and he is an engineer

From 4 it is clear that Kalyani is engaged to Rakesh. So he must be the doctor by 2. So Rajni is engaged to Kamal and he is an IAS officer

Don't look for any world records to be broken at this summer's Olympic Games in Los Angeles- thanks to the pollution!

PEEKING INTO THE COMPUTER

S. Arun-Kumar Paritosh Pandya
R. Chandrasekar R. Ramanujam
Kamal Lodaya

THE computer has, so far, remained a black box. We examine below, broadly, how a typical computer functions, its basic building blocks, the manner in which they are organised and also how they communicate with each other.

A program, we have said, is a sequence of actions. When a program is entered into the computer the actions are executed in accordance with the program statements. But programming languages are many and each one of these has a different sort of statement . If a computer has to understand them all, it is necessary to translate them into a common basic set of instructions which, in fact, bring about the required actions.

Figure 1 shows the way a computer is organised. We first look at the Central Processing Unit or CPU, which is the "brain" of the computer. It has an **Arithmetic and Logic Unit (ALU)** which contains electronic circuits to perform simple arithmetic and logical operations like adding two numbers or comparing two numbers. These circuits are similar to the ones used in electronic calculators.

Where do the numbers themselves come from? They are available in what are known as **General Registers** (GRs), also present in the CPU. Each GR can store the value of one variable (in the binary form, of course).

A computer instruction usually specifies some simple arithmetic or logical operation over one or two variables e.g ADD GR1 to GR2, or IS GR7 LESS THAN GR3? The variables over which an instruction operates are called the **operands** of that instruction.

A CPU cannot have a very large number of general registers. But we know that programs can be very large, containing thousands of variables. In order to store them the computer has a **memory**, which consists of several words (registers) to hold variables. However, these, unlike the GRs, are used only to store values: all computation is performed in the GRs. Thus, a program action

X ←Y+ 2

becomes, in machine instructions,

```
LOAD Y into GR1
ADD 2 to GR1
STORE GR1 in X
```

Normally the instructions are executed in the order in which they occur in the program. But sometimes it is necessary to execute a part of the program only under certain conditions. Consider the following statement to find the absolute value of an integer variable X.

```
if X<0 then ABSX=-X
        else ABSX=X
```

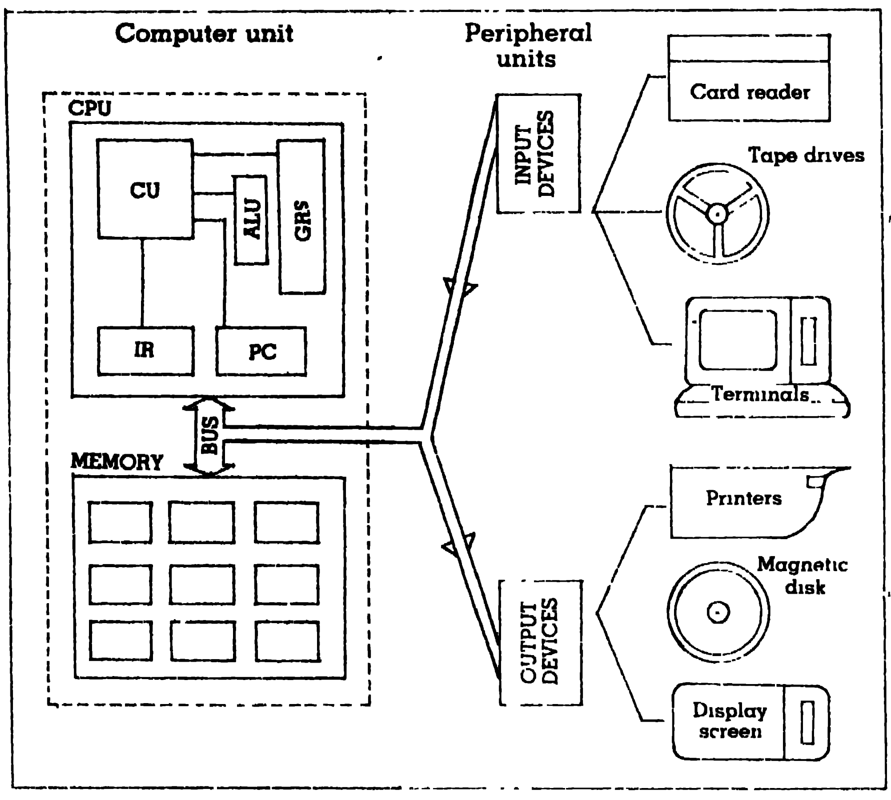


Fig. 1 Computer organisation

In order to write such programs, most computers provide conditional jump instructions JUMP IF TRUE and JUMP IF FALSE. Using the condition testing instructions and conditional jump instructions we can write quite elaborate programs. The above program is translated into

```
LOAD X into GR1
IS GR1 LESS THAN 0?
JUMP IF FALSE to ELSE
THEN: STORE GR1 in GR2
NEGATE GR2
JUMP to DONE
ELSE: STORE GR1 in GR2
DONE: STORE GR2 in ABSX
```

If the condition X<0 is true, the JUMP instruction is skipped, and the instructions starting at THEN are executed. An unconditional jump to DONE follows. If the condition is false, the conditional jump to ELSE is taken, following which, proceeding sequentially, we reach DONE.

In the program above, we have used variable names such as X and Y. These are stored somewhere in the memory and have to be located (there are no memory locations called X and Y). This is achieved by a technique called **addressing.**

There are many ways to specify an address. We might be looking for 25, Fireman Street (direct addressing),

only to be told that Alice doesn't live there anymore. She has moved near the bridge on the river Kwai (indirect addressing), and on-the-spot enquiry reveals that she's in the *teesri manzil* (indexed addressing).

In computer terminology, this translates as follows. The normal variables of a program are addressed directly, for example, X might be mapped to location 25. Array variables such as MANZIL[3] are indexed. Parameters for procedures are indirectly accessed, since a parameter like KWAI may stand for different variables in different calls of the procedure.

So we would have

1: LOAD [25] into GR5 (direct)
2: LOAD [[KWAI]] into GR5 (indirect)
3: LOAD MANZIL[3] into GR5 (indexed)

The first instruction moves the contents of memory address 25 into GR5. The next one uses the contents of memory location KWAI as an address, and moves the contents of that into GR5. The final instruction takes the contents of MANZIL, adds 3 to it, and uses the result as an address. KWAI and MANZIL can in turn be direct, indirect or indexed addresses (however, most computers limit the number of levels through which this business can be carried). Since the third instruction requires some arithmetic to be performed in the computation of the address, MANZIL usually has to be a general register of the CPU. If we assume that KWAI is 30 and MANZIL is GR3, the various operations will take place as shown in Figure 2.

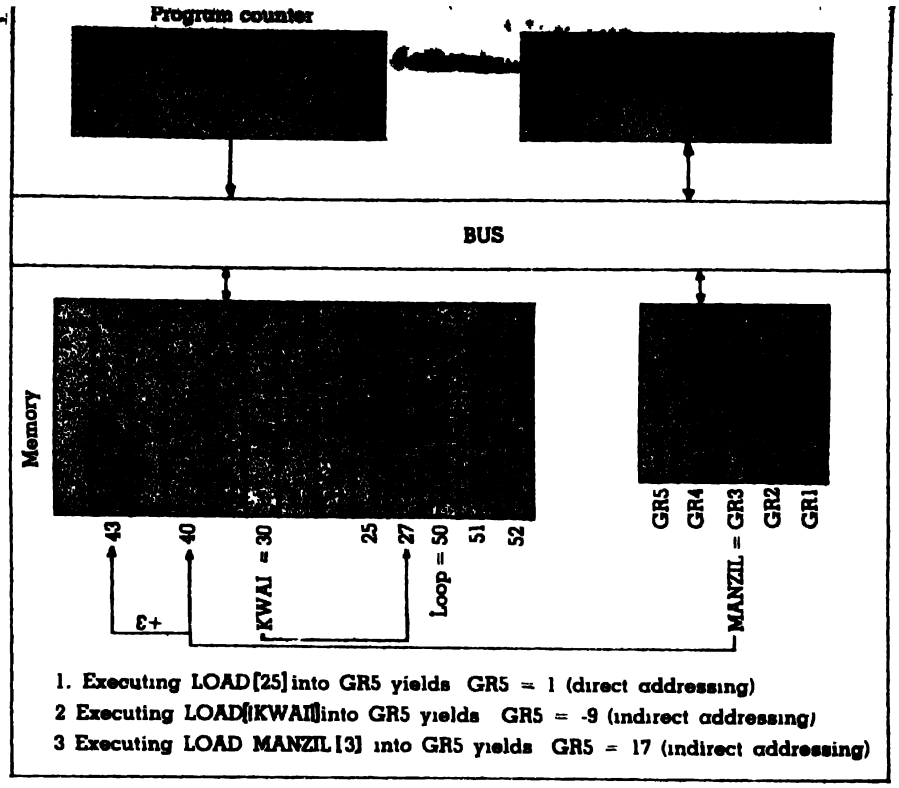


Fig. 2 Addressing modes

If you have been following the procedure with an eagle eye, you must have noticed the following: we said that X and Y made no sense to the computer as such, so some addressing mechanism had to be provided. But we seem to have conveniently overlooked the fact that labels like LOOP and ELSE are again just names which mean nothing to the computer! What, then, is

JUMP IF FALSE to LOOP

supposed to mean?

For that matter, we can ask a more fundamental question: where is this program that the CPU is supposed to be executing? It can have millions of instructions, so it is clearly impossible to have it in the CPU. The solution to this problem was discovered by John von Neumann: store the program too in the memory of the computer!

Thus a memory word may contain either an instruction or a variable value. This means a program instruction too has an address. From Figure 2 we see the LOOP instruction has the address 50. Hence, the jump instruction will actually be

JUMP IF FALSE to 50.

From Figure 2, one can realise that it is possible to treat program instructions as data variables. If, by mistake, the first instruction of the program were

LOAD [52] into GR1.

Such bugs are avoided by using a programming language. The translator will correctly output the machine instructions corresponding to our program.

The machine, however, exploits this ambiguity between program and data in its own operation. This will be seen below.

Getting information in and out

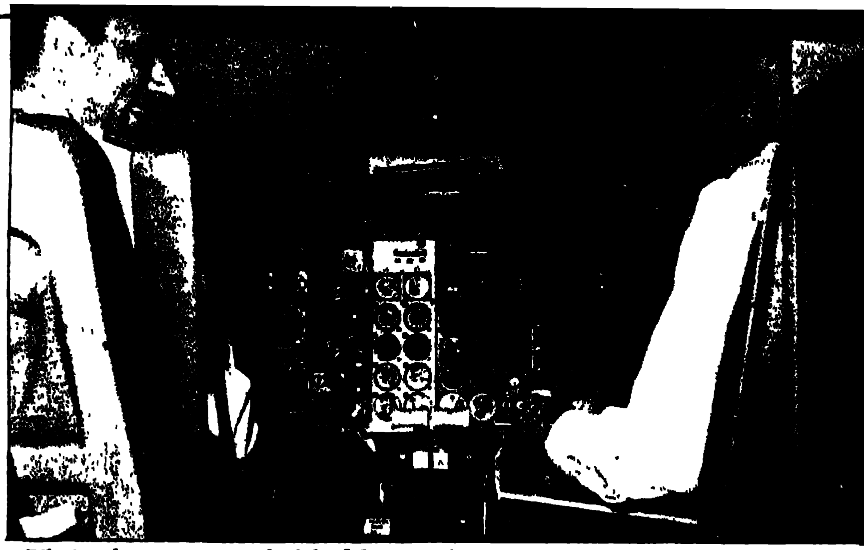
We have seen the working of the CPU and memory. However, how do things get into and out of them? The computer has to interact with the outside world in some way. For instance, a keyboard may be used to read in characters, or a TV screen-like display to print them out. In a process control application, we may well find a computer using a digital temperature sensor as an input device and a battery of ON/OFF switches as an output device.

A computer will have some instructions to handle these **peripherals** as well. (A modern trend is to use micro-mini computers to perform control functions that were previously confined to the central processor, making the peripheral 'intelligent'.) Typically, instructions for input/output devices are of the type:

READ from DEVICE
into MEMORY-ADDRESS
WRITE from MEMORY ADDRESS
onto DEVICE
and SEND a CONTROL COMMAND to DEVICE.

The last named is exemplified by the command "Skip to a new page" for a line printer.

There is another reason why a computer might have to transfer information outside it. Very often, it might be necessary to process and store such large amounts of information that the



Piloting the computer is the job of the central processing unit

memory can't store all the necessary data (even the largest computers can store only a few megabytes—millions of 8-bit bytes). Cheaper (but slower) bulk-storage devices like magnetic disks and tapes are used as alternative forms of storage.

Such secondary storage media have another use. A computer's memory is continually reused by the programs that run on it. How can data be kept on a nearly permanent basis, as certain master files must be? The solution is to put them on disks or tapes, which can be conveniently carried about and connected to the system whenever necessary.

For a secondary storage device, the instruction might be slightly more sophisticated, since the device itself has an addressing structure. So you will have something like

READ from DEVICE ADDRESS
into MEMORY ADDRESS,

may stand for READ from DISK 1, CYLINDER 3, SECTOR 5 into LIST[200]

Most peripherals are based upon electro-mechanical components, making them inherently slow and error-prone. They might even be orders of magnitude slower than the electronic CPU of the computer. Their operation is, however, quite independent of the working of the CPU. A certain optimisation suggests itself: divide the input/output instruction of the computer into two instructions, one for initiating the I/O process and another to check if it is completed.

Consider a program to control a teletypewriter (which is universally known in the computer world as a TTY). Let's say the two instructions are START-WRITING and CHECK-IF-WRITTEN. Now a program to print a character does the following:

□ The character is put into a buffer (which is just a memory location) and the instruction

START-WRITING from BUFFER
onto TTY

given. This activates the TTY, which starts the process of printing the character This might take, say, 20 milliseconds.

□ But the CPU is much faster: it works in microseconds! The program meanwhile goes on to execute anything like 20,000 other instructions.

□ After squeezing in this bit of extra work, the program executes

CHECK-IF-WRITTEN TTY

By this time, the next character to be printed might have been generated. As soon as CHECK-IF-WRITTEN gives a "yes" answer, the program promptly puts the next character in the buffer and gives another START-WRITING instruction.

In this way, the teletype can be working at its full speed of 50 characters per second, while the CPU is managing to (possibly compute also) produce an output for it. The program is said to be output-bound, or more generally *I/O-bound*. A program which does little I/O and goes on doing large amounts of processing is said to be *CPU-bound*.

This whole sequence is very familiar to most of us: it is just like a manager telling her junior officer what to do, getting him started on it, checking if he is through with it, and giving him more work thereafter. Note that the manager can continue with her work after she has issued her instructions.

There is an irritating detail to be taken care of. It is tedious to keep on checking if some work is complete or not (as any manager will attest to). A better idea is to have an I/O device **interrupt** the CPU to indicate that it is finished. The program now simply issues the START-WRITING instruction, and goes on to do other work until interrupted to indicate that the character is written.

Before this seemingly complex sequence puts you off computers, you must understand that all this is what happens behind the scenes—in a programming language, you simply give a WRITE statement or equivalent. The language translator will take care of the details of the printing.

A closer look at hardware

So far, we have been talking about instructions being "executed" by the CPU. But how does the CPU go about it? We trace it by examining the processing of one instruction:

IS GR3 LESS THAN X?

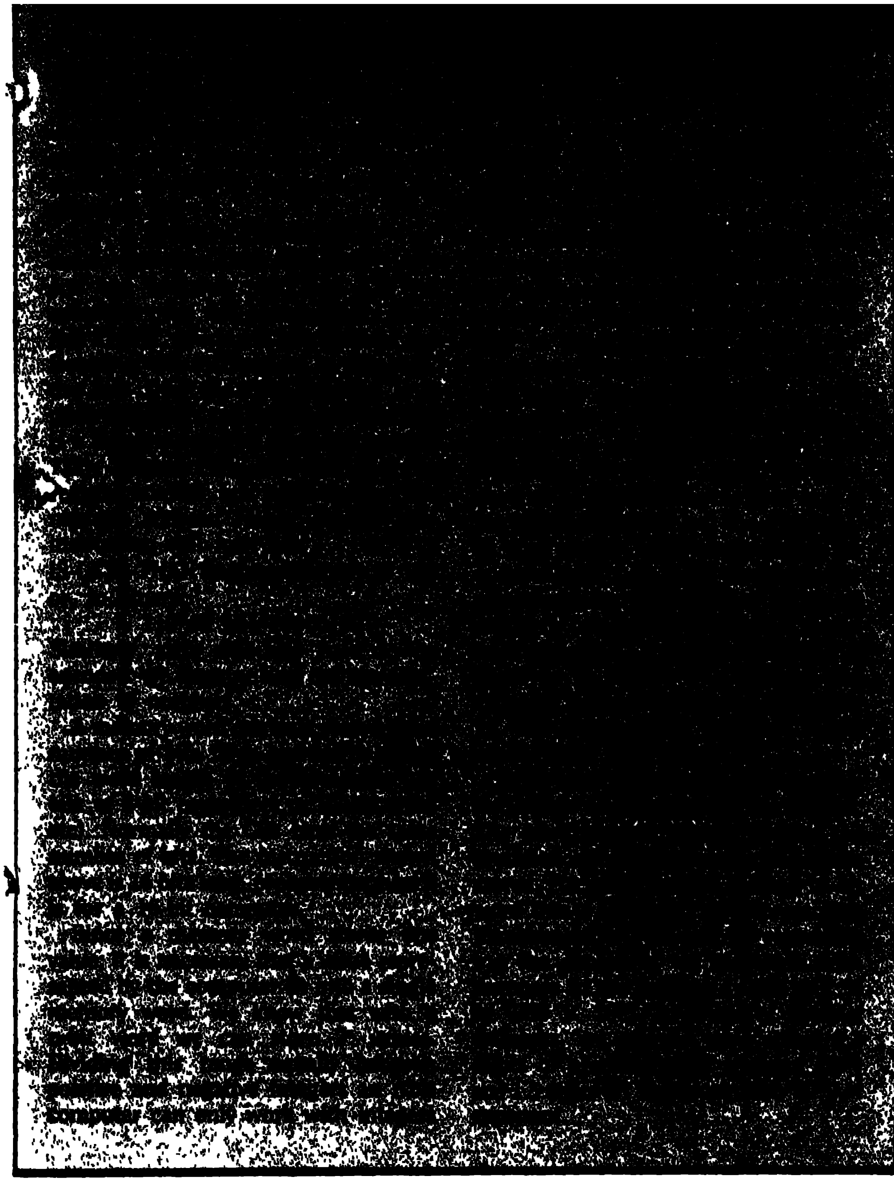
The CPU has two special internal registers:

□ The Instruction Register (IR) holds the instruction being executed.

□ The Program Counter (PC) keeps track of the instruction location. Initially the PC is loaded with the address of the first instruction of the program.

□ The Control Unit (CU) of the CPU uses these registers to execute the instruction in two stages.

Fetch: When the execution of this instruction begins, the PC must be having the address I. The CU sends a command to the memory to read this address. The value at this address, which is the instruction "IS GR1 LESS THAN 0?", is loaded into the IR. The PC is incremented by one so that now it points to the next instruction. The current instruction can be broken up into the operation code IS-LESS-THAN, the first operand GR1 and the second operand X (see Box). This is done by the decoding circuitry in the CU.



Execute: Operation of this stage is very much dependent upon the specific instruction.

□ If the instruction is an arithmetic or logical instruction, appropriate commands are given to the ALU to perform the operation.

□ If the instruction is a LOAD or STORE, commands are sent to the memory to transfer the appropriate value from source to destination.

□ If the instruction is a JUMP (with the condition satisfied), the PC is changed to the value supplied in the instruction.

In this case, we have (deliberately) used a hybrid sort of instruction, which requires a memory access as well as calculation by the ALU. The CU first sends a command to the memory to read the contents of address X. A value is returned and the ALU compares this with the value in GR1 (which is inside the CPU). It will then set some internal switch, so that if the next instruction is a conditional JUMP, it can make use of the result of this instruction.

The various parts described above are interconnected in such a way that information can be transferred between them. The modern computer uses for this purpose what is known as 'bus' which is just a set of wires over which a word of data or address can be transported. In some computers there is a single bus for data, address and control signals whereas some use different buses for these. The block diagram (Fig. 1) shows the various building blocks of a typical computer.

Newer architectures

So far, we have been dealing with the classic, or von Neumann, type of computer organisation. But this is neither the only possible machine architecture nor the best possible.

The main drawback of the von Neumann approach is that the machine is forced to operate sequentially, one word at a time. Each instruction is fetched and processed one by one. One way of overcoming this is to have many CPUs sharing a common memory (in which the program resides). In the program fragment

LOAD X into GR1
ADD GR3 to GR2

the two instructions can be executed in parallel by two separate processors.

Such a **multiprocessor** architecture is faster, but only in a limited way. Supposing you have the instructions

LOAD X into GR1
ADD GR1 to GR2

you simply have to execute them sequentially! Performing the second before the first is disastrous. In general, a data dependency chart of the whole program has to be prepared to recognise possible parallelism. Research is progressing on **data flow** computers, which will be able to do this.

A simpler solution is for the programmer to write her program in several logically unconnected parts. Each of these could be executed by one CPU with its own memory. This is called a **distributed** architecture.

Of late, there has been a lot of interest in distributed systems, since they can support "networking" of computers—linking a number of them so that computers at different places become accessible. The potential applications of networking include: electronic mail, information retrieval (share prices, hotel and travel information, weather reports, news), home banking, tele-shopping and so on. But, as can be expected, managing the data may turn out to be a major headache. □

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CROSSING THE BAR

WE have heard of the Tibetan Book of the Dead. But a Book of Death for the Living? An anthology of death *does* seem a morbid project And a number of sub-titles at once spring to mind: death by drowning, death by garrot, death by overindulgence, death by jogging, death in the afternoon, death at night, death at the races and death on the road...

However, this is not a practical "do-it-yourself" guide. Nor is it a step-by-step description of the process of dying or a geography of the other world as provided by the Tibetan Book of the Dead *(Bardol Thadol)*. It is a highly colourful anthology of writings on death and dying (of death of animals, of children's death and so on) with a number of famous last words and epitaphs thrown in. The compiler is the distinguished poet, D. J. Enright, whose name was recently mentioned in the race for Britain's Poet Laureateship after Poor John Betjeman, ahem, died!

In his preface the compiler himself admits his initial reservations about the Book. But he was probably compelled by the thought that the subject of death is "one of exceptionally large and exceptionally common concern". He also discovered that there are no "real experts" on the subject. Naturally. Dying is quite unlike dreaming. You don't indulge in it day after day (or, more properly, night after night) and get up to talk about it at the Club. Your first encounter with death is your last. If it isn't, what you have encountered is not death but a near-death experience, which is quite something else again. In fact it is the so-called near-death experience that has been receiving a lot of attention and coverage some of which we could do without.

Planchet-pushers may tell you anything, but death by itself belongs to that "country from whose bourne no traveller ever returns to carry tales". Thus, by definition, this anthology is incomplete. The compiler is the first to agree that he could go on "compiling" until death itself parts one (the compiler) from the other (the anthology). But what is surprising is that Mr. Enright says he would be happy to be so engaged for the rest of his life! Our own feeling in the matter is that a *memento mori*, however exquisite or sublime, begins to pall after a while. And you cannot live all your life in black (not unless you happen to be a pall-bearer or an undertaker by profession!)

Fortunately for Mr. Enright it is the publishers and not the Grim Reaper himself who parted the compiler from his anthology which, once you accept the inevitability of the subject turns out to be full of passages of strange beauty and power. Happy reading!

Vithal C. Nadkarni

The Oxford Book of Death
Chosen and edited by D. J. Enright.
Oxford University Press.
Price £9.50

Population Dynamics of Infectious Diseases. Theory and Applications. Edited by Roy M. Anderson. Chapman and Hall, London 1982. 368 pp. Price not stated.

THIS book, by several authors, is one of a series on Population and Community Biology projected by the publishers. It deals actually with the applications of mathematical modelling in the dynamics of infectious disease. It does not purport to give any definite answers or guidelines

Those who are new to the subject may well start with the last chapter by D. J. Bradley, which discusses the rationale, the significance and the shortcomings of mathematical modelling as representations of epidemiologic situations.

In brief, from the known facts about the mode of onset and cycle of transmission of an infectious disease, attempts are made to prepare models to represent various stages of the disease process and for the cycle of continuation of the process in a community. In such models, represented by mathematical equations, symbols are used for the different variable parameters which can affect the outcome. Approximate values are assigned to these symbols (parameters) and calculations made for the outcome of the stage or process concerned. For example, the rate of infection of mosquitos by malarial gametocytes is an important factor in perpetuation and spread of the infection. The rate of infection of mosquitos would depend on the density of mosquito population in a given area, the frequency of biting of humans by mosquitos, the number of infected humans in the area, the proportion of infected persons who develop gametocytes, and the infectivity of gametocytes for mosquitos. Some of these factors can be estimated from available reports or sample studies. For others we can assign arbitrary values, based on our understanding of the problem, and proceed to calculate, from our equation, the rate of infection of mosquitos. If when compared with observed rates, our calculated rates are far out, our values for these parameters must be revised, either by making further observations and/or by assigning other arbitrary values which can achieve a closer fit with observed findings.

The main success in modelling is claimed for malaria where Ross calculated that the disease could be eliminated by vector control rather than by chemotherapy of patients. This was amply borne out by events, but to this reviewer it appears that Ross, with his deep understanding of malaria epidemiology may well have come to the same conclusions without mathematics or that his modelling and calculations were informed by his special knowledge.

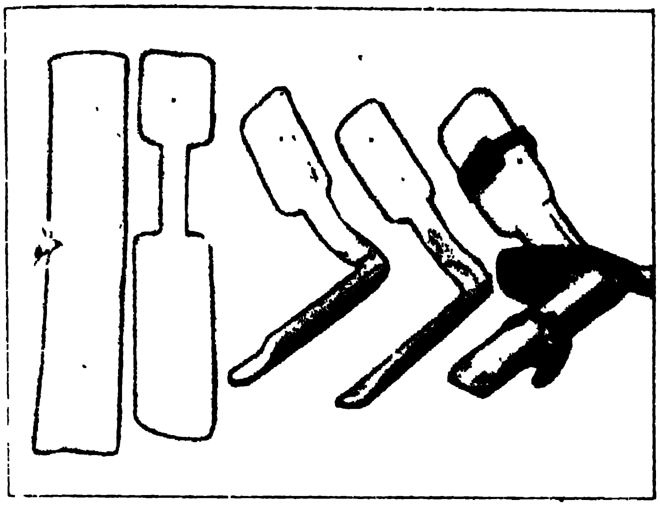
Many diseases, in spite of all efforts, persist in the community at almost the same level, which can be represented by a transmission rate of unity. If we identify the variables which affect this transmission rate, we can calculate what value of each variable would be necessary to bring down the transmission rate to less than one, so that the infection may die out. It is then possible to estimate the amount of effort required in the case of each variable, to bring it down to the desired level so as to concentrate our efforts on the one requiring the least effort, as also to decide whether we have the resources and capacity to take the necessary action.

It will be appreciated that this approach is still very untried, and a lot more study is required before we can assess its usefulness. Fruitful advances are likely to occur only if there is close collaboration between the mathematician and the epidemiologist, each understanding the other's language. One difficulty of the present book, for an epidemiologist who does not have a mathematical bent, is that no explanation is given for derivation of the various equations presented as representative of different processes. This makes it difficult to determine whether the mathematical representation is correct and in accord with one's understanding of the process If the epidemiologist is required to understand and participate in the process this is an omission which should be remedied in future editions.

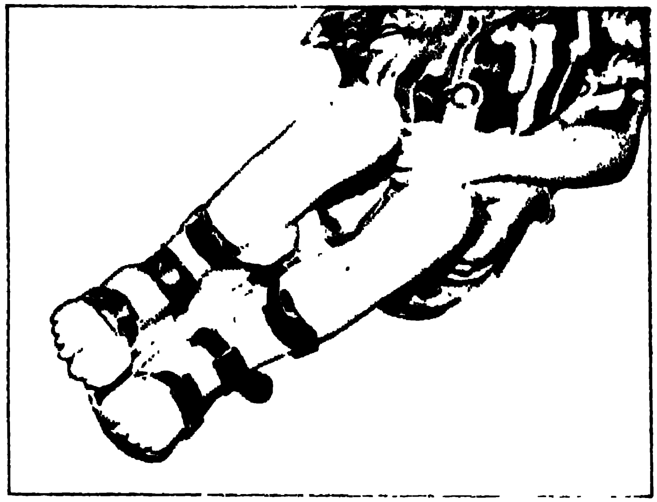
A. N. D. Nanavati

A 'helping hand' of bamboo

Bhaskar Banerji J. B. Banerji



1a: Night splints at different stages of construction



1b: Polio victim with night splints

Viklang Kendra, a rehabilitation centre for the handicapped at Bharadwaj Ashram, Allahabad, UP, has developed 'appropriate technology' to help the rural handicapped. The *Kendra* has developed several kinds of tools and aids from cheap and indigenously available material. Lately, bamboo and cane have been used to make a variety of prosthesis, artificial substitutes for a missing part of a body like a leg or a hand, to help the poor handicapped. The conventional ones, made of steel, leather, etc are expensive, and beyond the reach of our rural poor. And this section of population is most exposed to accidents in field operations.

Bamboo and cane are endowed with several inherent advantages, which are fully exploited in the construction of prosthesis and other aids. Some of these properties are: the inherent mechanical strength, high tensile property, easy malleability, extraordinary lightness of the material, and above all its easy availability. Though commonly used for furniture and other construction purposes, cane and bamboo have never been used enmasse to help the disabled.

But the story at the *Kendra* is different. Several cane and bamboo appliances are now routinely made, rehabilitating thousands of rural handicapped. Some of these appliances are. bamboo splints, bamboo/cane walkers, cane crutches, cock-up/Volkman's splints, cervical collars, bamboo calipers, spinal jackets (lumbo sacral belts), splints for the hand, wheel chairs and lower extremity prosthesis.

The above require simple and unsophisticated techniques. For night splints (1a and 1b), bamboo, at least four inches in diameter, is cut into thin, long strips. By application of alternate heating and cooling treatments, strips are bent at the centre to a right angle and then reinforced by thick mild-strip steel. Padding of foam and strategically placed leather strips provide biomechanical functions and prevents planter flexion at ankle joints.

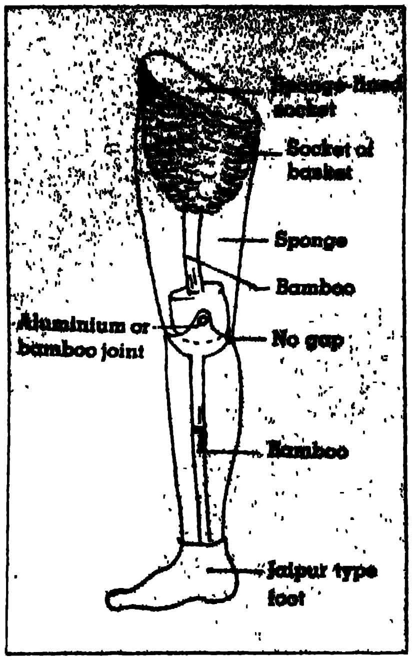
2: Walkers made of cane/bamboo

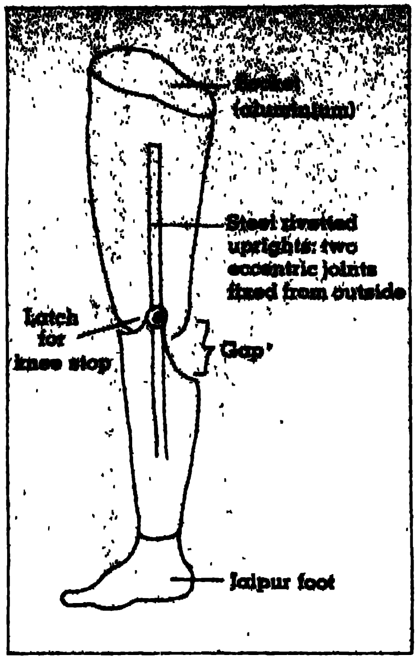
The design features of bamboo/cane walkers (2) conforms to standard walkers made of pipes. For greater structural strength, reinforcing cane pieces are placed strategically and fixed with nails and finally covered with a fine variety of cane. The walkers are effectively used as a walking aid.

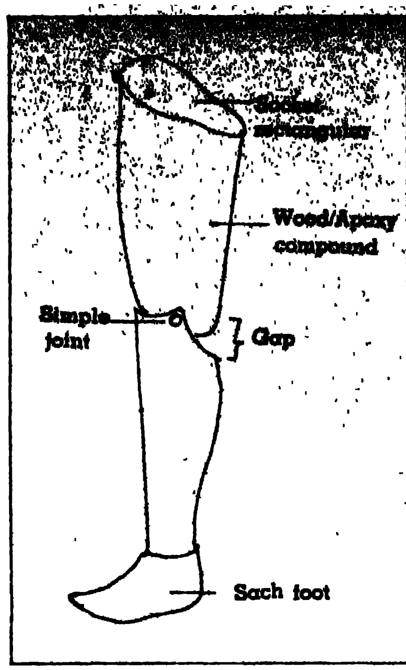
Cane crutches, are also made to standard specifications.

Cock-up splints (3a) to prevent palmer flexion at wrists, are made in the same manner as night splints. However, here the bamboo is bent distally to an angle of 60°. The appliance extends from below the elbow to the level of wrist joints. Volkman's splint (3b) is similar in construction to the cock-up splint, except that the appliance extends to tip of the fingers and a thumb outrigger is also put. It prevents palmer flexion at the wrist and at all the joints of the hand.

Bamboo prosthesis represents a unique effort to make prosthesis of bamboos. It is an endoskeletal

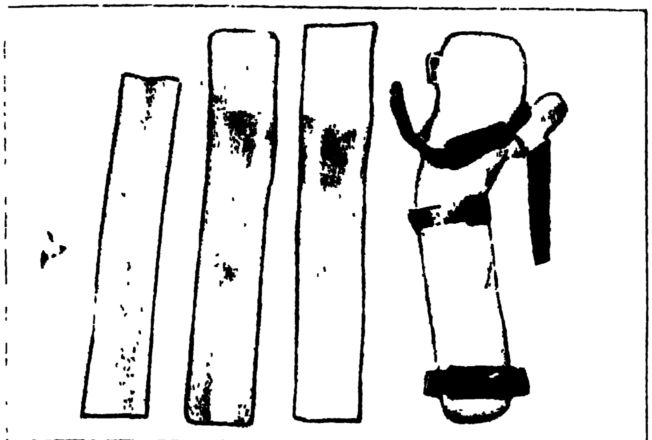




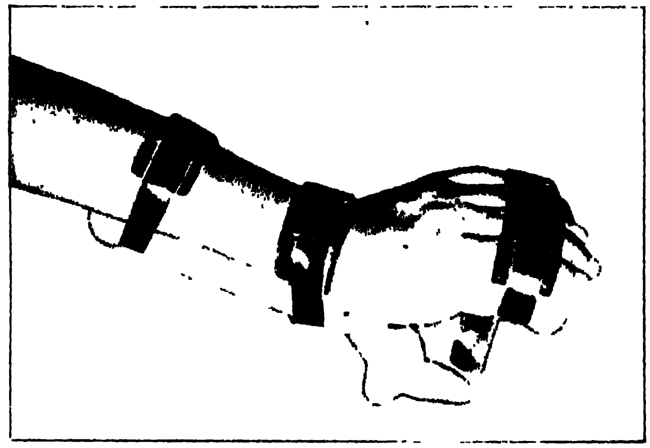


Differences between cane-bamboo prosthesis and other types of prosthesis

	Our prosthesis **Endo skeletal**	**Jaipur prosthesis** **Exo-skeletal**	**Conventional prosthesis** **Exo-Skeletal**
Consistency	Soft, like a normal limb It has a lurch due to the elasticity of cane/bamboo	Hard No elasticity and lurch	Hard No elasticity and lurch
Socket	Rectangular socket made of basket (cane), lined by sponge Permits aeration of amputated stump No Sweating It is specially advantageous for tropics	Socket beaten from aluminium sheet Does not permit aeration of amputated stump Sweating + + +	Socket shaped from wood or moulded epoxy-resin Partial aeration ± through a valve (A) Sweating present
Body of thigh	Soft Covered by rubberised stockinette Skeleton is made of bamboo or cane	Hard Covered by stockinette, coloured by fevicol Aluminium, shape is welded	Hard Covered by stockinette Epoxy compound or poly-propylene
Knee joint	Made of bamboo Single axis joint Control on motion due to a spring unit which gives resistance to motion, enables the leg to move harmonically and normally Flexion angle 170°	Made of steel with drop lock to keep it in place Double axis joint No control on motion Flexion angle about 140° only The leg unit has to have a gap to accommodate the thigh	Made of steel, double axis Double axis No control on motion Flexion angle 100° to 120°
Shin	Demountable clip type of joints for cane or bamboo shin	Shaped aluminium leg	Shaped moulded on wood or plastered mould
Foot	Jaipur style foot adds to the versatility of the limb All movements possible to a limit	Jaipur foot. only elasticity is from the foot	Shaped moulded on wood or plastered mould
Use of irregular pathways	Stress and strain on rough roads much less due to the elasticity of cane	Stress and strain + + + due to rigidity of aluminium	Stress effects more due to heavy weight
Patient acceptibility	+ + +	+ +	+



3a: Cock-up splints for wrist-drop cases

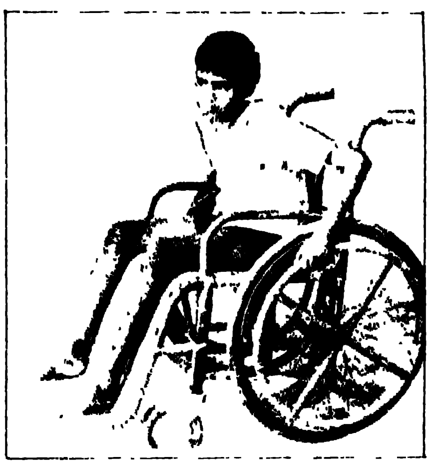


3b: A hemiplegic wearing a Volkman's splint

variety of prosthesis. The socket is of a cane basket and the foot piece is a Jaipur foot (please see box item).

And, we also have a cheap, non-folding type of cane wheel chair, beautiful in its simplicity (4). The front wheels are a conventional six inches and the rear wheels are bicycle tyres. Manufacturing time is only one and a half days.

The construction design of bamboo calipers is similar to that of an ordinary calipers (5a and 5b). A wooden clog, however, is used as the base instead of a shoe. Depending on the need, calipers can be used as an ankle-foot orthosis,



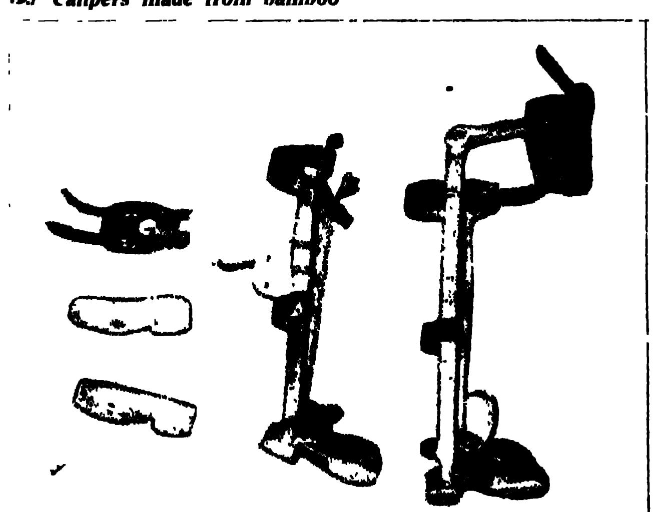
4 : Sturdy, cheap cane wheel chairs fit for rough roads

knee-ankle - foot orthosis or hip-knee-ankle orthosis

Hence, bamboo and cane orthosis and prosthesis represent a viable alternative to high-cost, sophisticated aids. Though organised research has not yet been undertaken to 'standardise' them, trials and their use have made them effective under rural conditions This cottage industry also provides employment opportunities to the villagers. □

The authors are actively involved in designing cane/bamboo prosthesis at the Viklang Kendra at 13, Lukerganj, Allahabad

5a Calipers made from bamboo



5b: A polio victim at work on a Kutti machine

ROMANCE OF RADIUM

'MADEMOISELLE SKLODOVSKI' The name was announced A thin pretty girl of seventeen got up timidly and walked across the reception room of the employment agency She had grown fair curls for several weeks, so that she could pin them up firmly and had practised a stern, calm expression appropriate for a governess. Her interview went very well. She had a perfect command over German, Russian, French, Polish and English. She had excellent references, and was the daughter of a physics professor. She was selected. From half a rouble a lesson her earnings now shot up to 400 roubles a year with free boarding, lodging and laundry. Manya Sklodovski was relieved that things had worked out so well for her. She had to get this job, to see her beloved sister Bronya, through medical school. She planned to educate herself after that.

Those were hard years for the Poles. Russia had overrun Poland and harassed her people, condemning the intellectuals among them to do all kinds of subordinate jobs. At the time, Prof. Sklodovski was impoverished financially mentally and physically. But his children Joseph, Bronya, Hela and Manya had consoled him saying, "We are young and strong. We will work and succeed". So Manya worked as a governess for three years till Bronya completed her studies. she then returned to Warsaw.

Once in Warsaw she regained her intellectual ambitions and re entered the 'Floating University' On the wall of the Sklodovski house was a precision baròmeter which Manya admired as a four-year-old. In a glass case there used to be a gold leaf electroscope and several other laboratory instruments which fascinated her Her father had told her that they were "physics app-a-ra-tus" A funny name which the little girl repeated again and again, till they formed a tune 'physics apparatus . '. She always wanted to play with them. Now at last she could indulge her childhood interest. At the Museum of Industry and Agriculture, she held a test tube for the first time in her life' Later, counting her savings, rouble by rouble, she boarded a train to Sorbonne—beginning her journey from obscurity to fame

At Sorbonne, she led a life of monastic simplicity, half starving and freezing with cold in the cheapest attics available. Her budget was only three francs to cater to all her needs including fees. Manya, (now called Marie), could have shared a room with other girls, but she prized her solitude Subsisting on bread, eggs, fruit and sometimes radish she became a shadow of a human being.

But Prof. Lippman recognised deftness, precision and originality of thinking when he saw it. So Marie was entrusted with a research project. Working with incredible stubbornness, she attained her first goal. At the end of term she was declared first in the M.Sc. examination in physics in 1893. But her reaction was to rush out of congratulating crowds to buy some presents to take home.

Back in Warsaw she was awarded the "Alexandrovitch Scholarship" but she returned to Paris to study mathematics. Once more she entered the dreary round of stinting and starving. She expressed her inner feelings during this time in a poem.

Pitchblende, the uranium ore, from which the Curies extracted radium

"Ah! how harshly the youth of the student passes,
while all around her, with passions ever fresh,
Other youths search eagerly for easy pleasures, ..."

Humiliated by an unhappy love affair, she was determined to love only science but Mother Nature planned otherwise. She was introduced to Pierre Curie by Dr. Kopalski, in the hope that he could let her work in his laboratory at the School of Physics and Chemistry in the Rue Lhomond. Curie was impressed by this pretty, intellectual Polish woman of rare genius and her tranquility was disturbed. She obtained her Master's degree in Mathematics in 1894 and returned to Poland During the correspondence that followed, her resistance to love and marriage melted like snow and the hermit woman finally married Pierre Curie on July 26, 1895. They had a very happy time and on 12th September 1897 Irene was born. Her daughter and famous biographer Eve wrote that "The idea of choosing between family life and a scientific career never crossed Marie's mind. She was resolved to face love, maternity and science, all three and to cheat none of them, by passion and will she was to succeed".

Searching frantically for a subject for her Ph.D thesis, she found Henrie Becquerel's publications on uranium salts emitting spontaneous rays of an unknown nature without exposure to light, ... and plunged into this virgin field. She was permitted to work in a damp, cold storeroom where her sensitive electrometer could not operate with precision. But she still persevered in her work, using an excellent method based on a sensitive instrument constructed by Pierre and his brother Jacques. She followed this method throughout her life, cross-checking the results with other techniques. The instrument could measure weak currents.

Developing intimacy with uranium rays, she found them to be unaffected by the chemical state of uranium or external factors like light, temperature, etc She announced that their incomprehensible strange radiations were an "atomic" property. This was a revolutionary hypothesis, since it was contrary to all accepted concepts on atoms. She argued that there must be some more such chemicals in nature. Examining other chemical elements in the pure and compound states, she struck on thorium which emitted similar rays. She christened this phenomenon "radioactivity", and elements like uranium and thorium as "radioelements". The game of labelling the salts, minerals, etc. as radioactive or radioinactive was continued with great amusement and excitement.

And in the spring of 1898 Marie found to her great surprise that pitchblende ore containing uranium oxide emitted radioactivity a great deal stronger than expected She repeated the experiment twenty times and arrived at the same results. Marie had discovered a new element. In her first communication to the Academy she announced "the probable existence of a new element in pitchblende ores, endowed with powerful radioactivity". Her paper was presented by Prof. Lippman and published in the proceedings to the Academy on April 12 1898. This publication opened the road to the new science of radioactivity, a road on

Pierre and Marie Curie at work in the early 1900s

which Marie Curie travelled with missionary zeal for the rest of her life.

The next step was to isolate this element This was a stupendous task and Pierre Curie joined his wife in her great adventure at this stage. The life partners, became collaborators in the laboratory in April 1898. Day and night the couple toiled together. They ground the pitchblende to a powder and dissolved it in acid, then boiled it repeatedly, froze and precipitated it. The handful of fine, black powder which they obtained by June 1898 was 400 times more radioactive than uranium. As the 'noose' round the culprit' was tightening they reflected that there were 'two culprits' not one. By July 1898 they successfully separated "polonium", which was named after Marie's beloved country. Poland at the time was erased from the geographical map, but found a place on the scientific map.because of Marie's patriotism.

Family correspondence was kept up in the midst of all these activities. Irene's progress was observed and noted meticulously in a diary and gooseberry jelly was prepared in the family tradition. On January 5, 1898 she noted, "Irene has fifteen teeth"— and between these homely notes, there came another important communication—"The new radioactive substance contains a new element to which we propose to give the name 'radium'." It was 900 times more active than uranium.

This second element was present in an extremely minute quantity. To separate it, tons of pitchblende had to be handled. The Joachimsthal mine in Bohemia provided them with pitchblende residue (after the removal of uranium) at a low price. The poverty of their haphazard equipment and miscellaneous obstacles hindered their progress. But with infinite enthusiasm and inexhaustible patience she worked as a physicist, chemist, engineer and even a labourer when the need arose. It was a killing job to carry the big containers, stir and pour off the boiling liquids for hours together Later she was to describe this period of their existence as 'heroic'. By 1902 they isolated radium and announced its atomic weight—225 and its other chemical properties. It was now found to be 100,000 times more active Contemporary scientists bowed their heads to this superwoman

But, Marie and Pierre, celebrated their achievement in their own characteristic unconventional way. They went down to their laboratory where they found to their great entrancement, beautiful, blue coloured containers, glowing on the shelf. This was the most memorable night in Marie's life when she sat and admired their handiwork, while Pierre caressed her hair with great affection

Marie and Pierre received Nobel Prize for Physics in 1903 along with Henrie Becquerel. With this followed a flood of fame and professional honours. Marie was awarded her doctorate in June 1903 and a University post in 1904. And there was a 'post-doctoral baby' Eve Curie. In 1905 Pierre Curie was elected a member of the Academy of Science But their happiness was shortlived.

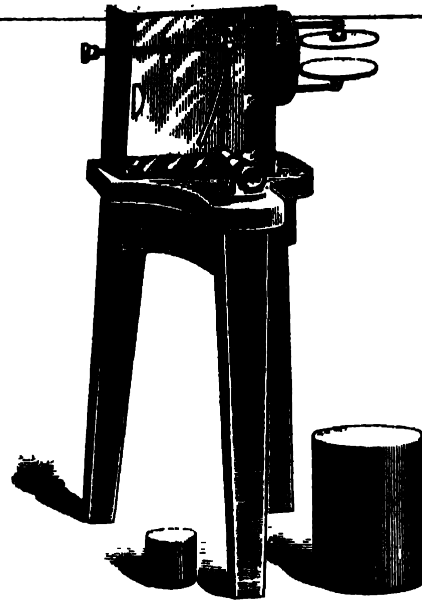
In April 1906, Pierre was run over and killed by a freight wagon as he crossed a rain-slicked Paris street. Deeply shocked by this sudden blow, Marie became almost dumb and icy. She refused to accept a pension and so was offered Pierre's post. She became the first woman chief of research work in May 1906

The day she delivered her first lecture, the classroom was filled with anxious faces. She started exactly where her late husband had left off. Tears rolled down the cheeks of the audience and she left as rapidly as she entered. She spoke on the theories of electricity, atomic disintegration, radioactive substances and so on, in her icy poignant voice.

In 1910 she published a monumental 1,000 page treatise on radioactivity compiling for the first time all the existing knowledge on the subject. Between 1911 and 1914 she wrote a series of general articles The consequences of the theory of transformations; the phenomenon of radioactivity substantiating the connection between matter and electricity; the reasons why explosions occur each time an atom emits radiation are some of them. She also introduced words like "disintegration" and "transmutation" into scientific terminology

At the Radiology Congress in Brussels in September 1910 she raised the question of official standards for radium. The Congress defined the "curie"—named in honour of Pierre—as a new unit corresponding to the quantity of emanation (radon) from or in radioactive equilibrium with one gram of radium. (In 1953 this was redefined as the quantity of any radioactive nuclide in which the number of disintegrations per second is 3.7×10^{10}). She received several honours from foreign academies. France awarded

A simple gold-leaf electroscope enabled Curie to detect radioactivity



her The Cross of Chevalier which she modestly refused.

But, Marie had to face a storm of mud-slinging at the Institute. M. Amagat was of the opinion that "women could not be part of the Institute of France." She lost the election to the Academy of Sciences by one vote. This chauvinistic attitude of France was perhaps corrected when in 1911, she won a second Nobel Prize in Chemistry for the description of the chemical properties of new elements. At the time, no other person had received this honour twice. She was accompanied to Sweden by Bronya and Irene. Twenty-four years later in the same hall, Irene was to receive the same prize. The Curies were a unique family bagging three Nobel Prizes! Special felicitations were arranged in her honour but a major portion of the money went directly to research and to friends and colleagues.

Though brickbats followed the bouquets, the Polish society of sciences had named Marie an 'honorary member' in 1911. In May 1912 a delegation of Polish Professors requested her to return to Poland to continue her scientific activities there. Torn between patriotism and duty, with great hesitation she refused this offer. The construction of the laboratory Pierre had dreamt off had begun. She could not leave France.

In 1914, the institution building was being constructed. The storms against her had subsided and she was at the zenith of her fame. The University and Pasteur Institute founded the Institute of Radium, which comprised of a laboratory of radioactivity placed under her direction. A laboratory for biological research and Curie therapy involving studies on cancer treatment was to be organised. She planned the buildings in such a way that, for the next fifty years scientists could work there. In July 1914, Rue Pierre Curie, the institution, was ready.

In August 1914 the first world war broke out. She raised funds and constructed the first radiological car Later she requisitioned 20 cars and transformed them into radiological cars fixed with X-ray machines. She organised 20 posts for radiological services. More than a million wounded soldiers were examined. She thus repayed her debt to her adopted country.

When the need arose, all her gold including medals and the Nobel Prize money were given away as war loans, though she knew fully well that it would all be melted away. She conducted courses in radiology and trained 150 technicians by 1918. Later she also helped Belgium, Italy and America in radiological training. She wrote a book on "Radiology in War" in which she never used 'I'. Later she refused the offer of The Cross of the French Legion of Honor.

In May 1920, an American journalist Mrs. Meloney, asked her "what would you like to possess the most?" Her answer was "I need a gramme of radium, but I cannot buy it. Radium is too dear for me." The journalist remembered that and launched a campaign for the 'Marie Curie Radium Fund' in all cities of the world.

Less than a year later, Marie Curie was invited with Irene and Eve to America. On May 20th in Washington, President Harding presented her with a small golden key to a coffer containing the gramme of radium.

Pierre had once suggested that they register a patent for their technique, so assuring themselves rights over the manufacture of radium throughout the world. This would have earned them millions. But she had dismissed the thought "it is impossible, it would be contrary to the scientific spirit. This discovery was not for personal gain but to benefit the whole of mankind." Marie had no regrets about this gesture. She confirmed them again and world newspapers proclaimed her the "benefactoress of mankind". In an old provincial capital of China, in the temple of Confucius at Taiyuan-fu, there is a portrait of Madame Curie, placed among the "benefactors of humanity", Descartes, Newton, the Buddha and the great emperors of China.

On May 17, 1922, the Council of the League of Nations unanimously named Madame Curie—Sklodovksi, a member of the International Committee on Intellectual Co-operation. She accepted. This was one of the most important dates in Marie's life. It enabled her to maintain absolute political neutrality in all circumstances This committee included great men like Albert Einstein, Prof. Lorentz and others. She became its vice-president and concerned herself with increasing the number of available postgraduate scholarships. She also struggled on problems like the compilation of an international bibliography for the documentation of research work, the unification of scientific symbols and terminology in scientific publications and the creation of tables of constants.

She planned a radium institute for free Poland, at Warsaw. It was to be a centre for scientific research and for the treatment of cancer. 'Buy a brick for the Marie Sklodovski-Curie Institute' became a familiar slogan in the Polish country side. The stock of bricks grew one by one and were transformed into walls, rooms and finally an institute. It was a historic day for Marie when in October 1929 America sent her one more gramme of radium. In 1932 her mission was accomplished. The Radium Institute was inaugurated. This was her last visit to Poland.

On December 26 in 1923 the Academy of Science celebrated the anniversary of the publication of her first report. Lost in the crowd were three grey-haired persons wiping their tears... Hela, Bronya and Joseph. Little Manya, the youngest of the family, had done them proud.

Students of all nations invaded her laboratory and she gave personal attention to each. From 1919 to 1934, 483 communications were published and 38 thesis were submitted. But her health often suffered. She had to undergo four surgical operations between 1923 and 1930.

She was tired now. She underwent kidney operations and had tuberculosis, her eye sight was failing again, rheumatism in one shoulder troubled her and she was suffocated by droning murmurs in her ears She was a victim of radioactive exposure; aplastic pernicious anaemia had developed. She died on July 4, 1934 at a sanatorium in Sancellemoz in France at the age of 67 years. Her coffin was placed above that of Pierre Curie as she desired. Bronya and Joseph Sklodovski threw handfuls of earth brought from Poland into her grave.

The French Society of Physics released a book on her birth centenary. It was entitled the "Colloquium on Medium and Heavy Nuclei." This was the tribute she would have appreciated most.

Bharati Bhatt

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The Answers *Continued from page 63*

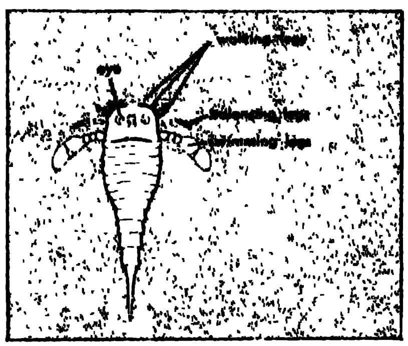
1. Euchromatin:—B: The word euchromatin is a combination of two Greek words *eu* meaning "good" and *khroma* or "colour". Chromatin are long, thread like structures of deoxyribonucleic acid (DNA) present in the nuclei of cells. They contain the hereditary information—the blueprint for life. Chromatin can exist in two phases, coiled and uncoiled and each phase has a distinctive staining pattern. It is hypothesised that the chromatin is genetically active in the uncoiled state This means that when uncoiled, the hereditary information in chromatin is being transcribed and translated into cell proteins. Euchromatin is the portion of the chromosomes that uncoils during interphase, the resting phase in the cell cycle, and condenses during cell division. It stains with low intensity

2. Eugenics:- C. The term eugenics was coined by Francis Galton in 1883. It is derived from the Greek root, meaning "to produce" and pertains to the production of superior offspring. Basically, eugenics is the study of human improvement by genetic means Its aim is to increase the proportion of people with better-than-average genetic traits Eugenic ideals are referred to in Bibical, Greek, Vedic and old English literature But, in its modern, scientific aspect it is essentially the study of trends and causal factors in human evolution. It draws on psychology, medicine and medical genetics, demography, sociology and other human oriented sciences

3. Eustacy:—A· Refers to world wide fluctuations of sea level, due to the changing capacity of ocean basins or the volume of water. It is a geological principle believed to occur due to the repeated advance and retreat of continental glaciers Sea level falls, when some of the Earth's water is bound up in ice sheets, during glaciations and it rises during subsequent deglaciations.

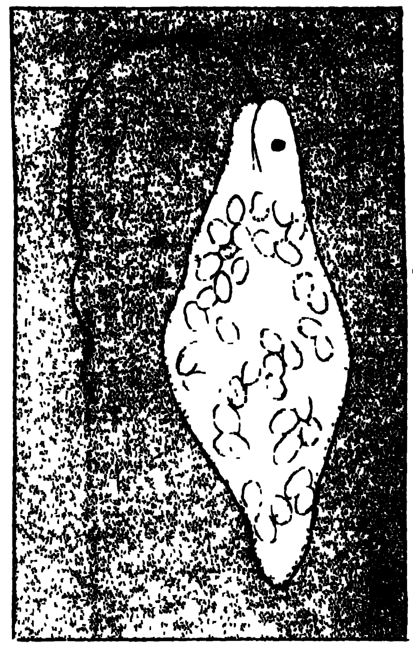
4. Europa:—C: Europa is one of Jupiter's satellites. It is named after a Greek mythological princess. Europa was the daughter of Phoenix, the king of Phoenicia She inspired the love of Zeus, who approached her in the form of a white bull and carried her away to Crete In Crete, she was worshipped under the name of Hellotis, where a festival Hellotia, is held in her honour. The satellite Europa has a diameter of 3,099 km and is about the same size as the Earth's moon.

5. Eurygamous:—A· Refers to those species—usually insects, which can mate in flight Eurygamous insects include the queens of bees, ants and termites who mate during a nuptial flight. They use the stored sperm to fertilise all the eggs they subsequently produce In most eurygamous insect species, the male is much smaller in size than the fecund female



6. Eurypterids:—B 'Eury' is a combining form of the Greek word *eurys* meaning "wide" or "broad" The term 'eurypterid', refers to an extinct group of aquatic arthropods, of the order Eurypterida which are rarely preserved as fossils Eurypterids appeared about 500,000,000 years ago and became extinct about 225,000,000 years ago. Though eurypterids are often referred to as 'giant scorpions', most of them were actually small and resembled horse-shoe crabs to some extent. They had segmented bodies and were thought to have inhabited brackish waters The largest arthropod ever known, *Pterygotus buffaloenis* was a eurypterid. It attained a length of three metres

7. Euthanasia:—A: Also called mercy killing from the Greek meaning "good death", refers to the painless inducement of death, especially the putting to death of incurable or terminally ill patients, at their request. Although illegal in most countries, it received sanction by both Socrates and Plato. An allied practice, morally acceptable to many people is that the life of a dying patient suffering intolerable and intractable pain, should not be needlessly prolonged by extraordinary means.



8. Euglena: C Is a genus of single-celled organisms, with both plant and animal characteristics It is considered a member of the protozoan (animal) order Euglenida or of the algal (plant) division Euglenophyta

Animal properties include motility which it achieves by vibrating its whip-like flagella and the presence of an eye spot Plant like features include the presence of chloroplasts, which enable it to synthesise its own food and a rigid cellulose cell wall Euglena are used to study cell growth and metabolism under conditions like high temperature, darkness, ultra-violet light and chemicals. Euglena are usually found in fresh water ponds.

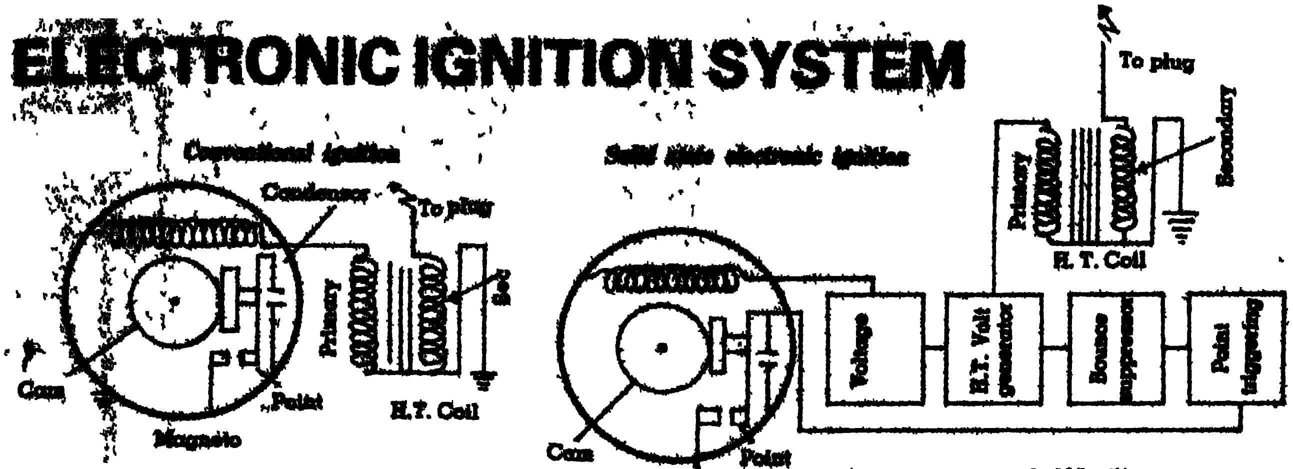
9. Eutectic:—A: Is a descriptive name used in metallurgy. It is assigned to an alloy or mixture of greatest fusibility—a mixture whose melting point is lower than that of any other alloy or mixture of the same ingredients. If an arbitrarily chosen liquid mixture of such substances is cooled, a temperature will be reached when one component will begin to separate in its solid form and will continue to do so, as the temperature is further decreased As this component separates, the remaining liquid becomes richer in the other component, until the composition of the liquid reaches a value at which both substances begin to separate simultaneously as an intimate mixture of solids. This composition is the eutectic composition and the temperature, the eutectic temperature.

10. Eudyptula:—C: Represents some birds belonging to the penguin family. Penguins comprise 16 to 18 species which belong to six genera They are most fully adapted to extreme cold and to water The species differ with respect to head pattern and size, but are dark backed and white bellied Penguins belong to the order Sphenisciformes. The smallest penguins are the little blue or fairy penguins *(Eudyptula minor)* which are about 40 cm in height. Young penguins are fed by regurgitation. Assemblages of half grown young penguins are often tended in creches or "kindergartens".

WIN A PRIZE!

EACH of the alternative answers given by us is a word beginning in *eu*. Write out these words and send them to us along with a list of as many words as you can think of with the prefix *eu*. The longest list will receive a full year's free subscription to SCIENCE TODAY. The closing date is 5 October, 1984. Regarding our May quiz, you have read but not responded? So we have extended the deadline to 5 August, 1984.

ELECTRONIC IGNITION SYSTEM



Point consumes nearly three to four amps

Point consumes only 100 milliamps

THE conventional ignition system of petrol driven 2-, 3- and 4-wheeler is now more than 50 years old. In an attempt to overcome its drawbacks like low battery voltage between the terminals on cold mornings, repeated attempts to start the engine leading to draining of the battery and burning of points, a firm in Madras has come up with a solid state electronic ignition (SSEI) system with a built in burglar alarm.

The SSEI system is capable of starting an engine at a low battery voltage (upto 7.5 V) against the conventional voltage of 12 V and keeps the ignition coil at a normal temperature.

It eliminates contact breaker point burning. The point consumes only 100 milliamps. The system is not affected by contact breaker point bounce. This improves high speed performance leading to fuel economy. Since there is quick warming up of the engine, acceleration and pick-up speed is improved.

The bi-polar spark extends the life of spark plug and eliminates metal transfer on the plug. Battery life is nearly doubled as starter consumes less current and the starter motor also functions for a longer period because of its quick action.

With the SSEI system there is a fuel saving of ten to 20 per cent depending on the condition of the vehicle, driving style and speed. Because of the added power to the engine what is achieved on third gear can be achieved on top gear and fuel is not wasted on load gears

Care has to be taken to check spark intensity and the plug gap has to be adjusted accordingly.

The burglar alarm device is activated by any unauthorised entry into the car. It can be connected to all doors, bonnet and dicky. If any of this is opened surreptitiously the burglar alarm bursts into action.

To overcome the weaknesses of the conventional breaker point method in engines, the firm also has developed a contactless triggering unit in compatibility with the SSEI system.

The unit is totally sealed. Hence dust, oil or moisture do not affect its performance. The firing accuracy will remain constant at all speeds

Contact-less device to measure jaw movements

SIEMENS

The contact-less device records the lower jaw movements

THE dental surgeon and orthodontist require an objective measuring procedure of the jaw movements for the diagnosis of jaw related diseases and the assessment of chewing habits, as well as dental dysfunction Previous procedures do not work without contact, therefore, they falsify the result

Now researchers in West Germany have introduced a unit the Sirognathograph , which measures the jaw movements without contact and displays them in real time in the three spatial planes with a high degree of precision The measurement requires only a few minutes

The magnet (5 mm x 6 mm x 9 mm) fastened to the lower incisors acts as transmitter for the jaw movement The positional changes of its magnetic field, for example,

during chewing, are detected by "antennae" to the left and right of the patient's head and these are transformed into electrical signals. Following evaluation by an electronic device, the movement of the jaw from the start position can be read off digitally in centimetres.

Technical applications for the measurement and recording of movements are also conceivable for the contactless measuring principle of the Sirognathograph. For example, moving objects in gaseous and liquid media.

It is possible to measure magnetic field changes of the order of only a fortieth of the Earth's magnetic field strength. If the magnet moves within a measuring volume of 4 cm x 4 cm x 4 cm, the signal voltage is linearly dependent on the magnet movement.

The sensor system consists of eight single antennae, the arrangement of which compensates for the influence of the (homogenous) Earth's magnetic field. Each individual antenna contains a Hall generator as magnetic field sensor. Rods of soft magnetic material linearise the antenna characteristic. By a complicated electronic activation (pulse technique) engineers were able to considerably increase the sensitivity of the sensors and thus greatly reduce thermal drift and noise, as well as the influence of external interference variables

New chip-making technique

SCIENTISTS at the General Electric Research and Development Centre, New York, USA, have invented a practical way to make next-generation microelectronic "chips" with present-generation processing equipment.

Their basic development is a "contrast-enhancement" material that is applied to semiconductor wafers at the beginning of the fabrication cycle. This coating greatly extends the ability of today's process equipment to make chips with ultra-small circuits

Aided by the coating, GE researchers have fabricated experimental microcircuits with linewidths of only 0.4 micron (a hundredth the thickness of a human hair), employing a commercially available optical projection system called a "stepper aligner". Without the coating, the stepper is limited to the production of circuit lines twice as wide—at best.

This 50 per cent reduction in circuit

Scanning electron micrographs of identical microcircuits produced with **(right)** *and without the new contrast-enhancement material*

widths is not the only benefit of the new coating. When employed in the manufacture of circuits with lines one micron wide and larger, it helps to produce chips with more precisely defined microstructures, resulting in improved operating characteristics.

The new coating approach is developed by a team headed by Dr. Bruce Griffing, a physicist, and Dr. Paul West, a chemist. Basically, the purpose of the coating is to pick up a faint image from the optical projection system and convert it into a sharp circuit pattern on the semiconductor wafer.

The main purpose of the research is to provide major cost savings for semiconductor manufacturers by making it possible to produce advanced VLSI (very-large-scale-integration) microchips without having to purchase new processing equipment. Processing equipment typically accounts for about 40 per cent of the capital investment required to set up an integrated circuit production line.

The various types of optical systems used in chip-making are employed to project the image of a tiny circuit pattern (contained on a photo negative like "mask") onto a semiconductor wafer coated with a light-sensitive photoresist The wafer is then etched to remove the exposed parts of the photoresist, leaving behind the desired pattern.

This approach has served the semiconductor industry well over the years. However, as manufacturers continue to reduce the dimensions of the transistors and other elements they cram onto microchips, the lenses employed in optical projection systems have begun to reach the physical limits of what they can resolve.

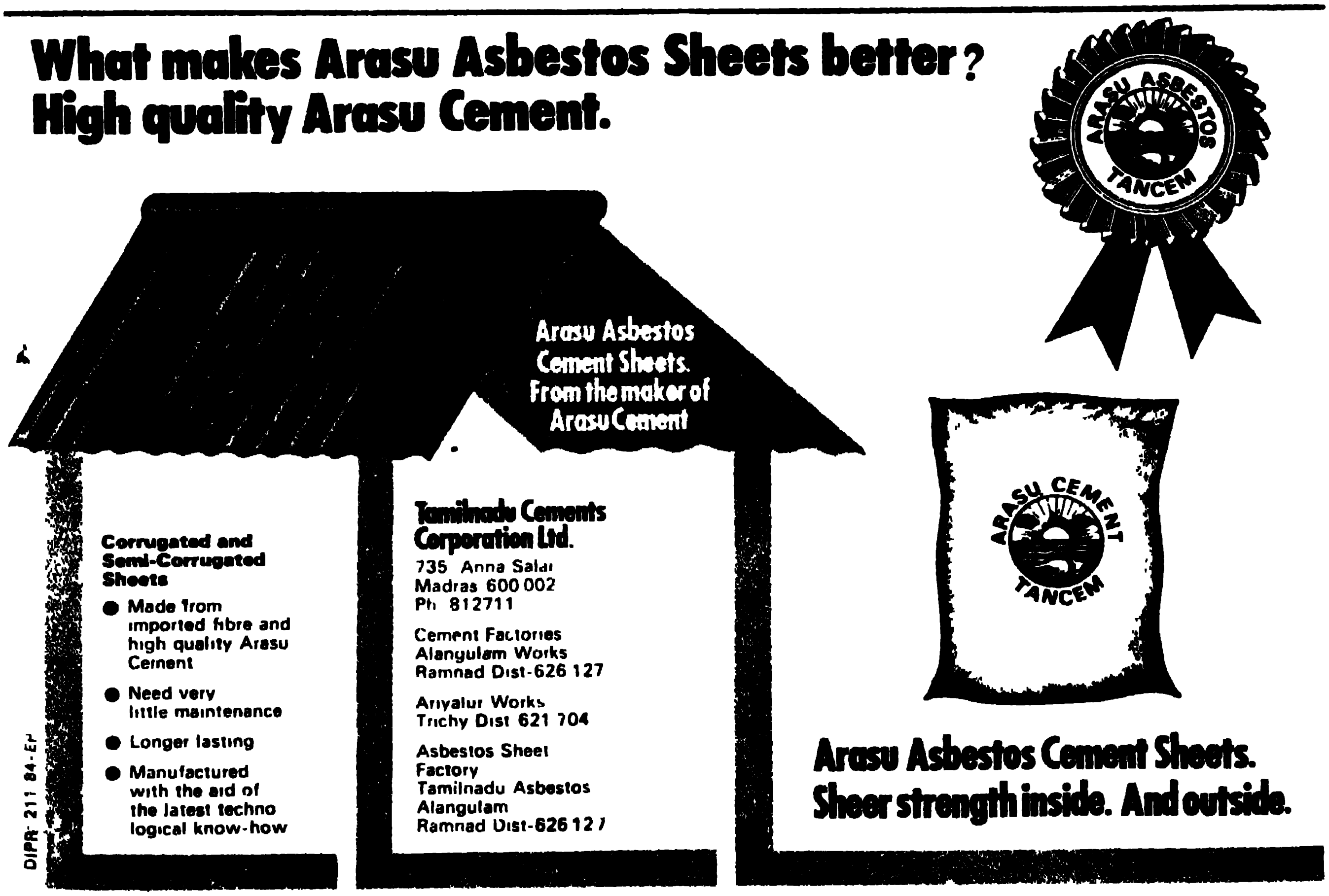
At present, most commercial microchips have circuit lines with widths of two to four microns—although 1.5-micron chips are beginning to appear in the market. As semiconductors manufacturers press toward one micron, the projected circuit images tend to be poorly defined because of lens resolution limitations, making it difficult to produce chips that meet specifications.

GE's contrast-enhancement material overcomes this limitation with the aid of a "photo-bleachable" dye. This dye is normally opaque, but becomes transparent when exposed to light of a certain wavelength

The special dye used has a combination of characteristics that makes it ideal for this application Most important among them is its ability to absorb light selectively. Once bleached, it readily transmits high-intensity light while, at the same time, remaining opaque to all other light impinging on it. As such only the areas of photoresist that should be exposed "see" the light.

In addition, the dye is compatible with common photoresist films. It can be put on top of the photoresist without disrupting the film's integrity And the material can be completely stripped off so that the photoresist can then be developed as if nothing had ever been done to it

The new process is extremely easy to implement; only two additional processing steps are required—one to apply a thin (0.3-micron) layer of contrast enhancement material (this is done with a spin-coating apparatus identical to that employed to apply photoresist), and the second to remove the material after the wafer has been exposed.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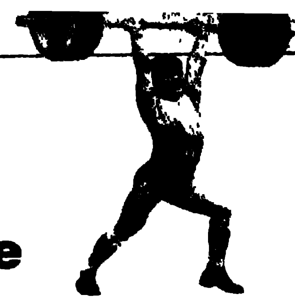
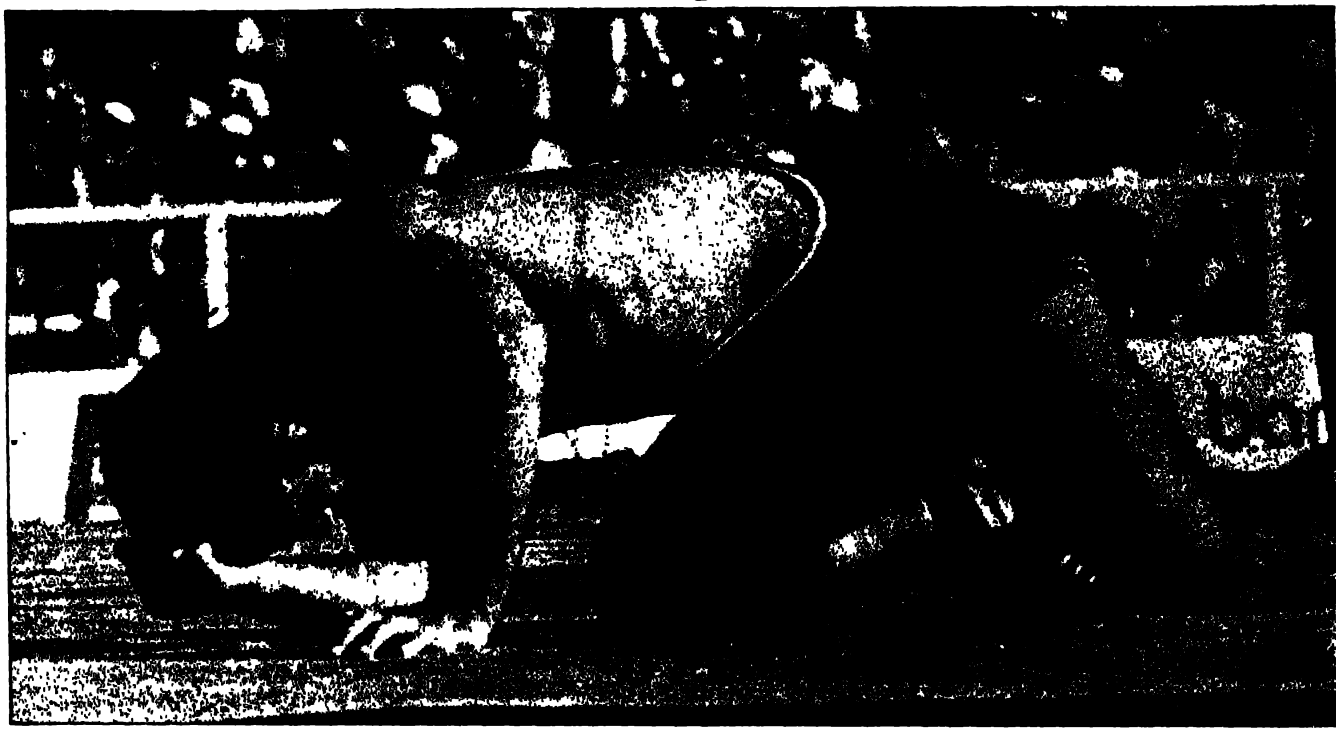


... what causes muscle FATIGUE



WATCH the Marathon winner towards the end: close to total physical breakdown, he runs forward propelled by will power alone, eyes rolling, lungs sobbing for breath, drenched in sweat, with muscles trembling in extreme fatigue,- he stumbles forward in agony to collapse in the arms of officials waiting at the finish line

What causes this muscle fatigue? The question is of fundamental importance because the performance of physical work, an activity with which fatigue is intimately related is one of the basic physiological functions of an animal

When the athlete is pounding across the track his muscles are constantly converting chemical energy into mechanical energy and heat

It has been found that when a skeletal muscle is made to contract repeatedly beyond its normal limits of use, the physiological efficiency of the muscle diminishes gradually and fades off leading to fatigue

A muscle can be regarded as an engine and like any engine it obtains its energy essentially from the "burning of fuel" The energy is provided in the form of an energy rich molecule ATP (adenosine triphosphate). Release of energy from the splitting of ATP into adenosine diphosphate (ADP) and phosphoric acid is what powers muscle contractions. The ATP must be synthesised continuously as there is no appreciable store of it in the muscle. It is also resynthesised from its products as soon as it is broken down.

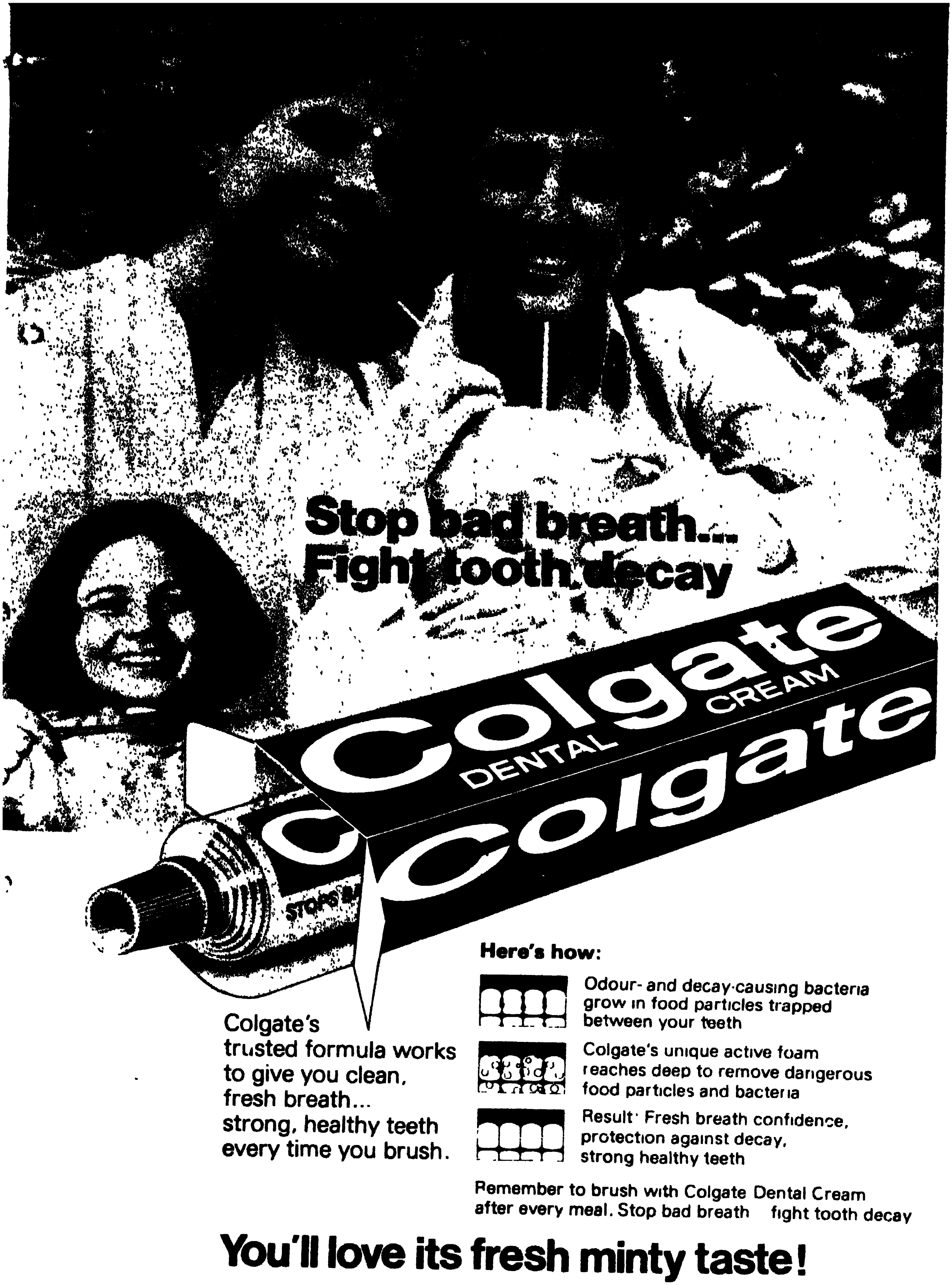
The "fuel" which is burnt to manufacture ATP in the first place is the food--mainly the sugar, glucose which is stored in the muscle. When glucose is metabolised one of the products formed is pyruvic acid. If the athlete is performing at relatively moderate or steady rate blood oxygen available is adequate. So the aerobic metabolism is predominant and the pyruvic acid would be broken down and carried away from the muscles as carbon dioxide and water One mole of glucose thus generates a remarkable 37 molecules of ATP, which is the driving force for muscular activity. The energy available thus lasts long enough to run a marathon

During more vigorous and strenuous work out the supply of oxygen from the blood is inadequate. This is because the heart, although working to full capacity, cannot beat fast enough to provide oxygen in required quantities This leads to tissue hypoxia that is reduced oxygen content. The anaerobic metabolism then takes on with the result that the accumulated pyruvic acid is converted to lactic acid. Not only is this mechanism less efficient as the ATP production is low but the lactates start attracting calcium ions from the surrounding tissues. Consequently the muscle freezes and pain ensues. The stiff muscles cause soreness. This leads to fatigue and ultimately exhaustion and this is called as lactic acidosis. Only when the muscles are rested does recovery take place with the blood flushing out the accumulated lactic acid

If the muscles are subjected to still more strenuous exercise they may develop focal necrosis in the fibres leading to leakage in serum of the muscle enzymes, like CPK (creatine phosphokinase), aldolase and further elevation of lactic acid levels or lactates. The muscles fibres may become slightly swollen this explains the soreness or tenderness of muscle following unaccustomed exertions

It is said that the injection of blood from a fatigued animal into a rested one will produce overt manifestations of muscle its action is observed to become tremulous movements are less adept and the coordination of agonistic, antagonistic and synergic muscles is less perfect, the rate of breathing increases the pulse quickens and the blood pressure rises. These changes bear out the hypothesis that fatigue is in part a manifestation of altered metabolism.

Prabha Srinivasen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Fight tooth decay
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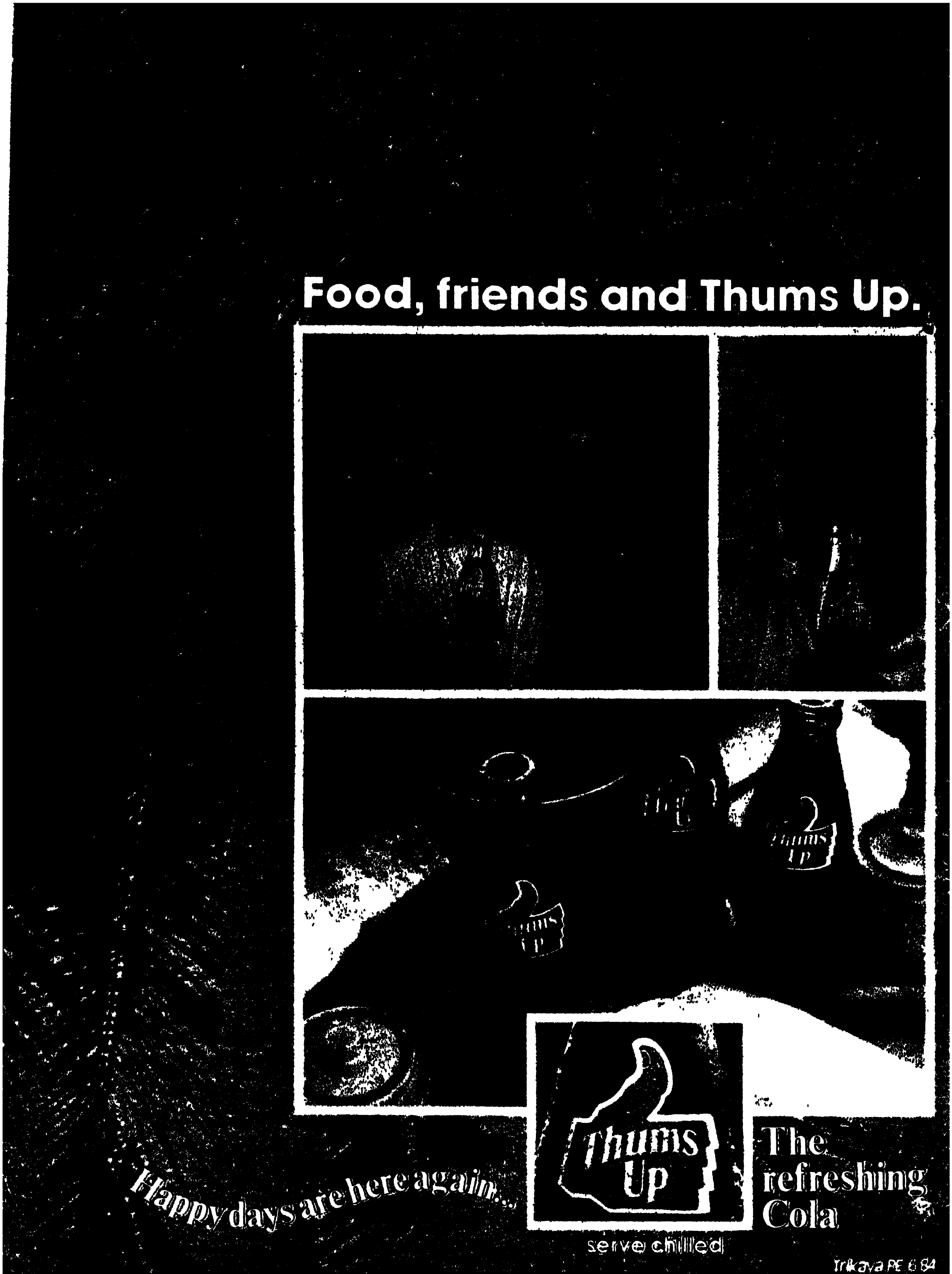
Odour- and decay-causing bacteria grow in food particles trapped between your teeth
Colgate's unique active foam reaches deep to remove dangerous food particles and bacteria
Result: Fresh breath confidence, protection against decay, strong healthy teeth
Colgate's trusted formula works to give you clean, fresh breath... strong, healthy teeth every time you brush.
Remember to brush with Colgate Dental Cream after every meal. Stop bad breath fight tooth decay
You'll love its fresh minty taste!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The refreshing Cola
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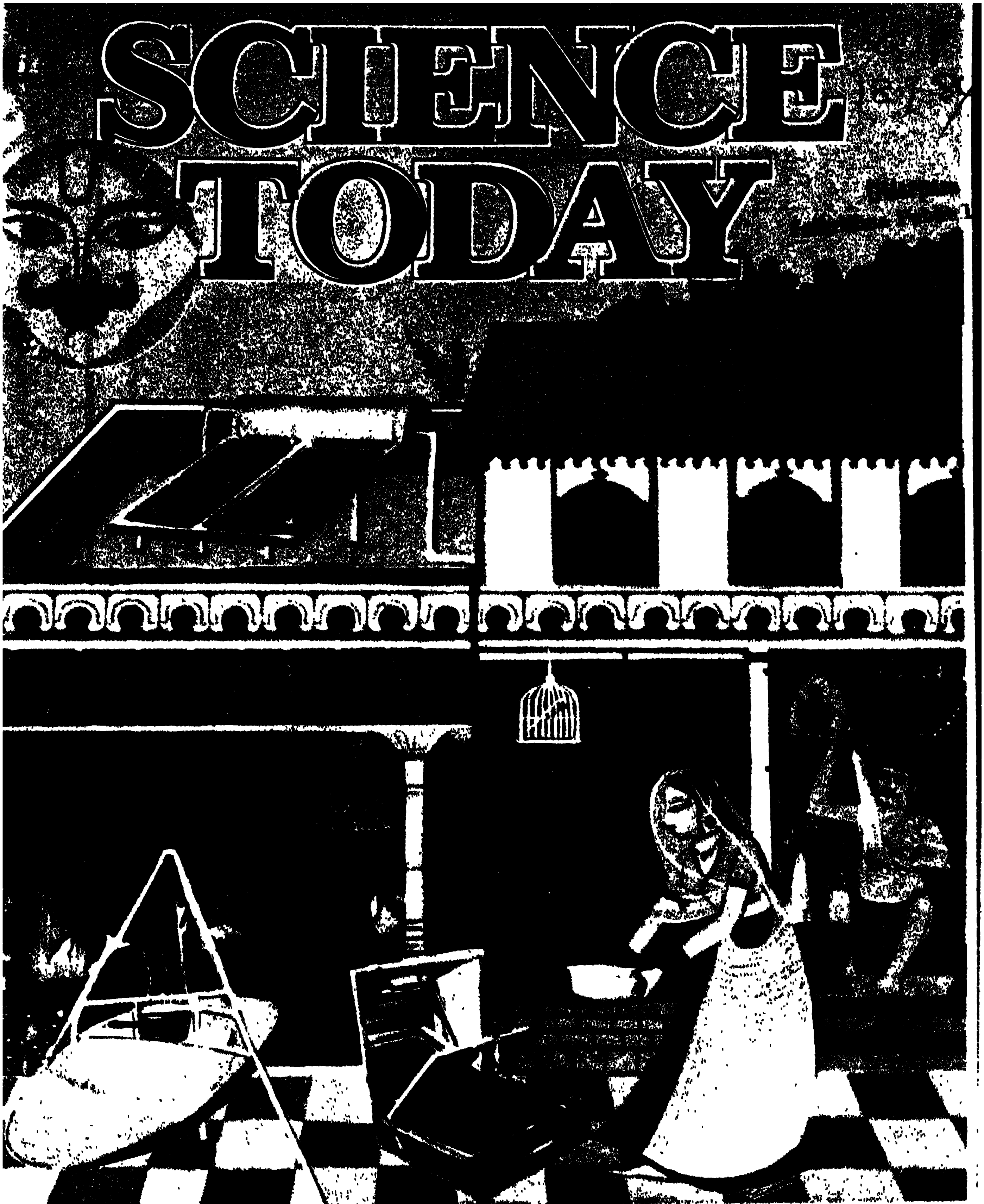
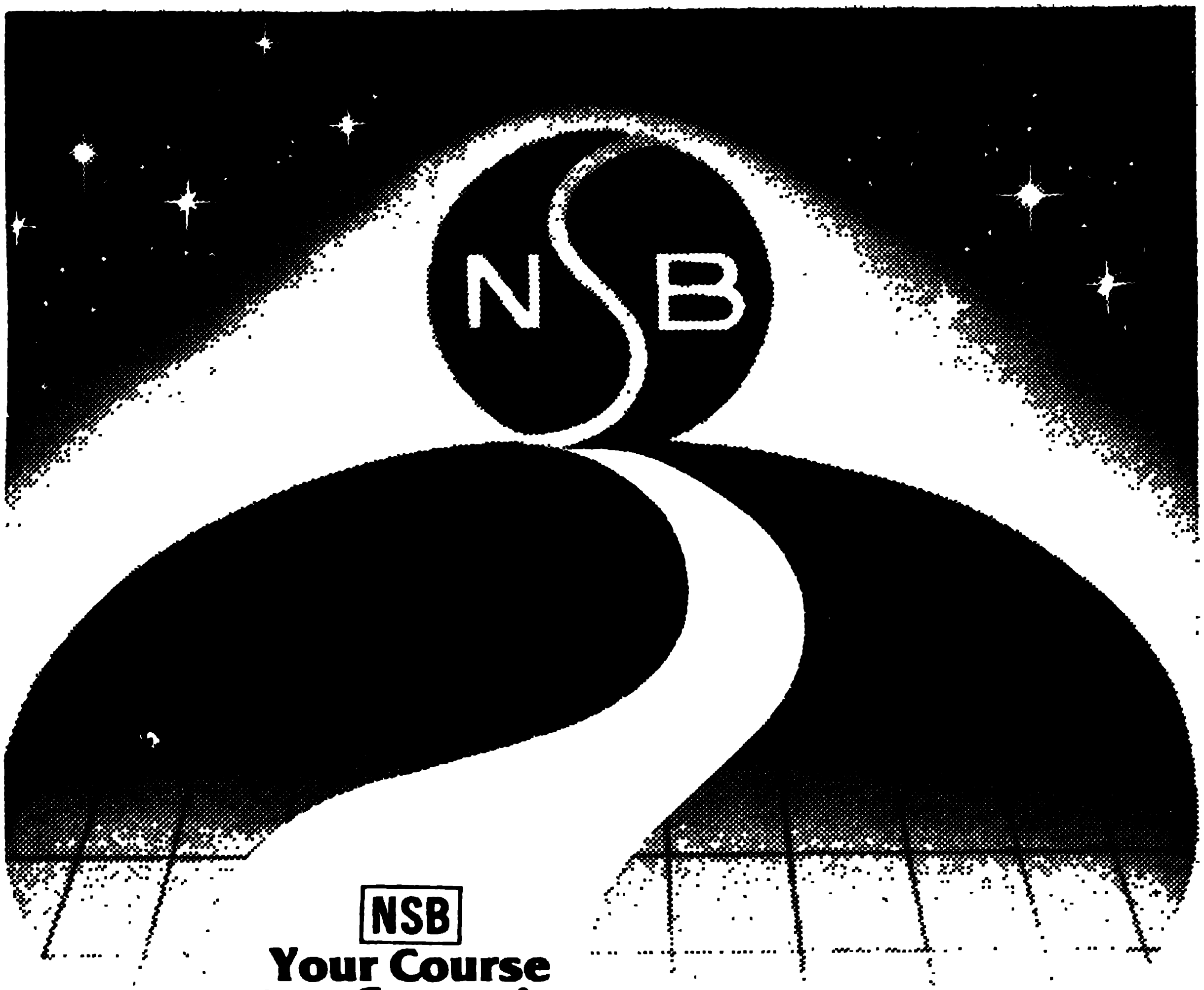


SOLAR ENERGY
will it reach our homes?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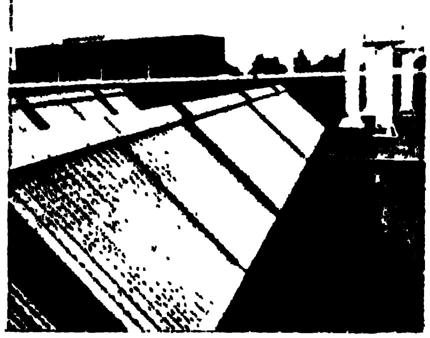
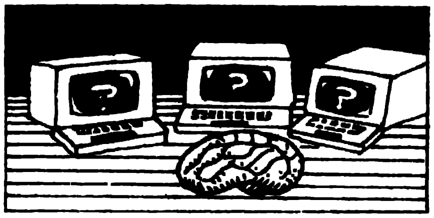
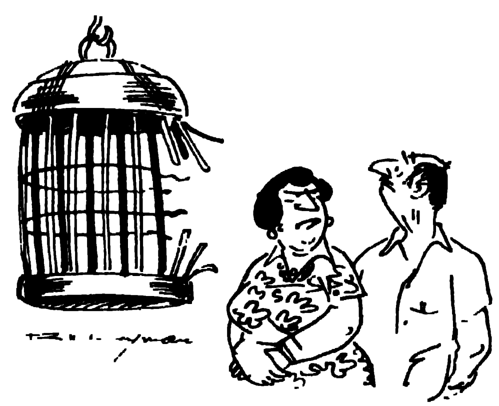




COVER ILLUSTRATION BY MUKUND TALWALKAR

You and your laser safe cracker!

Ah, I have found out why you have that shooting pain! You've been shot in the back...there's a bullet wound!



I told you he was too clever! You should not have given him that file when he asked for it.

Look! He just sweeps everything under the carpet!

Mr. R. K. Laxman, renowned for his "You Said It!" column in *The Times of India*, has also been associated with SCIENCE TODAY for many years. We are happy to congratulate Mr. Laxman on his winning the 1984 Ramon Magsaysay Award for journalism

Science and technology have, in recent years, become a dominant driving force of almost all pervasive changes. Our life styles, consequently, are radically being altered by the rapid and continuing developments in these fields. Some of these alterations have, in turn, set in motion changes in the social mores regarded as sacrosanct. The recent controversies surrounding issues like patenting a gene or ownership and rights of frozen embryos are cases in point. If society has to take decisions in this regard that are in the largest interest of the greatest number, then it is imperative that not only the opinion makers but also the rank and file adequately understand the implications of the frontier-pushing efforts in science. This assumes all the greater importance since the pace of these new developments is fierce and likely to radically alter the assumptions based on which a public debate is to ensue.

There is another dimension to this problem. Governments everywhere are increasingly depending on scientific and technological establishments and their achievements as means of ushering in social and economic justice. In a democratic set up then, the average citizen cannot afford to remain ignorant of the strides taken by science if he has to play a meaningful role. As Robert Cowen, science editor of the influential *Christian Science Monitor* states "the public perception of science and technology has become crucial both to the health of scientific enterprise and to the technological strength the nation derives from it". Science journalists are thus invested with the onerous responsibility of

What should then be the terms of reference for science journalists? Should they stick rigidly to the role of impassionate observers and be satisfied with reporting, albeit accurately, events and phenomena as they occur?

bridging the gap between the scientific community and the public at large.

What should then be the terms of reference for science journalists? Should they stick rigidly to the role of impassionate observers and be satisfied with reporting, albeit accurately, events and phenomena as they occur? Or should they also comment upon the possible consequences of scientific progress? Should they choose the latter path, is it possible for them to speculate objectively and not let their own ideological preferences to creep in and cloud the arguments? These are some of the questions that have to be seriously considered. At a seminar on "Science Journalism" organised by SCIENCE TODAY at Calcutta recently, several speakers addressed themselves to these questions. Although a consensus was not arrived at—and it is not possible to do so impromptu—it is heartening to note that a beginning has been made.

Cowen has narrated an advice he received on taking up science journalism in the early fifties. He was warned that (he should) "stick to the discoveries of the laboratory and leave *philosophy* to the political reporters". As science journalism in our country is young and perhaps at a stage where its American counterpart was when Cowen took his first hesitant steps, that warning should be considered more appropriate.

EDITOR

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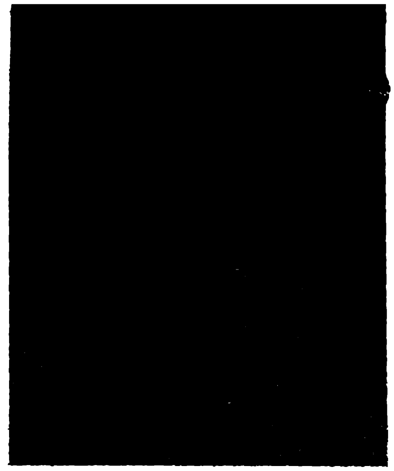

POTABLE WATER–A PIPE DREAM

We are happy to read "Potable water within our reach" (June, 1984) The Consumer Guidance Society of India tested five brands of water filter candles and only Sudarshan brand yielded sterile water. M/s. Sudarshan Electrical Industries Pvt. Ltd. Thane, (Maharashtra), are our licensees for the manufacture of water filter candles developed at the Central Glass & Ceramic Research Institute, Calcutta. The candles developed at the Institute have been thoroughly tested at the National Environmental Engineering Research Institute, Nagpur.

Even sewarage water with high bacterial count was bacteria-free after filtering through the candles. Indigenous raw materials are used in candle-manufacturing. The candles are impregnated with colloidal silver which disinfects water. Several hypothesis are there to explain this disinfection action: silver ions interfere with the metabolism of bacteria ultimately killing them; the bactericidal action of silver ions destroys coliform, staphylococci and typhoid bacteria in water; and silver in ionic concentrations, as low as 0.006 to 0.005 part per million, is lethal to *E. coil.*

The published article gives an impression that ceramic filters eliminate bacteria by filteration. This might only be partially true as it is the bactericidal action of silver ions that gives completely sterile water. Candles impregnated with colloidal silver are often marketed as stersyl candles.

P S. AGGARWAL

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The article is informative. Almost all common water contaminants are mentioned except fluoride ions

Fluoride concentration in water is almost negligible in India, though in some villages of southern Andhra Pradesh and northern Tamil Nadu, it is one of the major water contaminants, ranging from 3 to 8 ppm. The use of this water causes decay and yellowing of teeth, and weak gums. This observation was made by a team of Delhi doctors in a survey of a few villages in AP.

Fluoride concentrations, well below 0.5 ppm as in tooth pastes, is good for teeth and gums. But slightest increase in its concentration is harmful. A few wells in south-east Africa have water with fluoride content of 30 to 35 ppm and a lake has fluoride ion concentration of 60 ppm! The problem wherever present needs attention

PRADEEP SHENOY

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More colleges in AP

The article "There is unemployment ahead for engineers" (May, 1984) by Mr R G. Varshney and Mr. B L. Agarwal, is informative and analytical I would like to add the names of some more engineering colleges in Andhra Pradesh.'

Name of the Institution & Affiliation	*Type of Institution*	*Duration of course (years)*	*Qualification*
Vasavi College of Engg Hyderabad, Osmania University	Govt aided	4	Inter
Maturi Ventata Subba Rao Engg College, Hyderabad Osmania University	"	"	"
Bapatla Engg College, Bapatla, Guntur Dt Nagarjuna University	"	"	"
K.L. College of Engg, Vaddeshwaram, Guntur Dt Nagarjuna University	"	"	"

From 1983-84 the intake in all private engineering colleges in AP is restricted to 40 in each course, as the AP government has banned capitation fees

V. SUDARSHAN

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Vivekananda knew it all?

Regarding the article, "Two Cheers For General Relativity" (May, 1984), the similarity between the conclusions of spacetime singularity and the Vedic teachings by Swami Vivekananda showing that Hindu philosophers visualised the evolution and involution of matter and Universe in a similar way, is being realised by scientists today Volume II of *"The Complete Work of Swami Vivekananda"* reads.

"Out of what has this Universe been produced then? From a preceding fine Universe Out of what has man been produced? The preceding fine form. Out of what has the tree been produced? Out of the seed, the whole of the tree was there in the seed It comes out and becomes manifest. So, the whole of this Universe has been created out of this very Universe existing in a minute form. It has been made manifest now. It will go back to that minute form, and again will be made manifest Now we find that the fine forms slowly come out and become grosser and grosser until they reach their limit, and when they reach their limit they go back further and further, becoming finer and finer again. This coming out of the fine and becoming gross, simply changing the arrangements of its parts, as it were, is what in modern times called evolution. This is very true, perfectly true, we see it in our lives. No rational man can possibly quarrel with these evolutionists. But we have to learn one thing more. We have to go one step further, and what is that? That every evolution is preceded by an involution The seed is the fine form out of which the big tree comes, and another big tree was the form which is involved in that seed. The whole of this Universe was present in the cosmic fine Universe. The little cell, which becomes afterwards the man, was simply the involved man and becomes evolved as a man. If this is clear, we have no quarrel with the evolutionists."

Hence, the Hindu philosophers had conclusively visualised the nature of all matter and its existence in a cycle of evolution and involution Scientists having understood evolution are now also approaching the theory of involution based on mathematical theorems of general relativity according to which all matter would be compressed to a point with infinite density.

PRADUMAN KR. JAIN

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Proton decay

Five experimental groups with detectors in India, Japan, Switzerland and in Ohio and Utah in the US, say they have recorded phenomena that could possibly be interpreted as occasional decaying of protons, the building blocks of all matter. But they point out that the observations could be explained in other ways too.

The actual proof of such decay would have sweeping implications, for protons exist in the nucleus of all atoms and their decay would gradually destroy all matter in the Universe. The destruction would not occur, however, before the passage of billions of years.

The reports of the five groups were made at a meeting recently in a ski resort near Salt Lake City, USA. The Japanese experimenters came closest to making an outright claim of finding proton decay. They said that the advanced equipment placed in a mine at Kamioka appeared to have recorded two such instances.

The physicists working at Lake Erie USA, have concluded that the average proton lifetime must be greater than 200,000 billion billion billion years. The experiment appears to have ruled out one postulated process in which a proton would decay into a position and a pion of zero electric charge.

One reason for the intensive search for proton decay is that it has been predicted by several so-called grand unification theories. Such theories seek to incorporate most of the basic forces of nature within a single theoretical framework Over the last two years a team, with a detector in the Kolar gold mines of India, has reported several suspected proton decays Its representatives told the Utah meeting of a new one, bringing the number of seemingly strong candidates to four.

PRITHPAL SINGH

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Resources for tomorrow

The article "Vanadium—the Vitamin Metal" (June, 1984) by Prof M.A. Nabar was informative. I would like to add some more points about its medicinal value in homoeopathy.

Meta-vanadate of sodium is used as a tonic for the stimulation of appetite in early tuberculosis, in anorexia with states of irritation of gastro-intestinal tract and in aneamia. In homoeopathic *Materia Medica*, mention is made of a cure of fatty degeneration of liver and atheroma of the arteries with vanadium in a man of seventy.

N. SOLAIYAPPAN

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Dist Jabalpur, M P

Seminar on environment and human survival

The National Council of Science Museums, Govt of India, is organising a students' competitive science seminar on Environment and Human Survival' during July, August and September 1984

The seminars will be organised in each State and Union Territory at block, district, state and national levels, the top winners of all the block level seminars in a district will also participate in the district seminar and so on The top winners of the state level seminars will finally compete in the national seminar at New Delhi, on 12 October.

P. K. PALIT

Sr Information Asst
National Council of Science Museums
19 A Gurusaday Road, Calcutta 700 019

Women and science

I have been reading with interest your recently introduced feature 'Women and Science'. As a woman scientist I appreciate your efforts at providing scientific information, in simple but no less scientific words to a housewife about matters encountered in daily life, which are taken for granted. An average educated housewife of today, although aware of the contributions of science to modern living, often shies away from reading even popular scientific literature, thinking it beyond her comprehension.

One of the aims of the Indian Women Scientists' Association (IWSA), is to take science to masses, particularly to housewives and children. It appears that you also had the same approach in mind, when you started this feature. Please accept my congratulations for a commendable new introduction.

SUDHA C. GANGAL

A second look at earthworms

The popular belief that earthworms vastly improve soil fertility ('Growing Greenbacks From Worms', April 1984), could well be a myth.

The estimate that earthworms in rich soil turn over about 37 tonnes per hectare in a year, amounts to hardly 0.25 cm per year, even when spread out uniformly. This cannot contribute significantly to improving soil structure or chemistry. Moreover, earthworms cannot survive in poor soils and hence they cannot improve soil fertility They cannot carry out photosynthesis or nitrogen fixation, and are, therefore, consumers of energy leading to a decline in soil fertility, and not its producers. The allegedly higher potassium and phosphorus content in earthworm castings (as compared with surrounding soil) is due to vegetable matter in the worm's diet.

In short, presence of earthworms in soils that were already rich in fertility has led to a confusion between cause and effect. It is high time scientists took a second look at the matter without preconceived notions.

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Animal communication

I am a scholar in animal behaviour. The article 'How Animals Communicate' (May, 1984) was superb, though mainly putting forth general viewpoints

I would like to mention the latest developments in faunal-communication, known as Traco-Analysis Models (TAM) TAM also has its branches in chemical communication of animals For example, the sex pheromone, trans-7 dodecenyl acetate, of the false coding moth, *Argyroplace leucotreta*, is used by the oriental fruit moth, (*Grapholita molesta*), as an intermediate pheromone between sex and alarm basics.

Two modes of the action of pheromones have been recognised on their recipients The first has a releaser effect of a particular pheromone by which the behavioural responses occur immediately The second, the priming effect, is slower, but often longer-lasting response is oriented with endocrine glands or is of morphogenetic nature.

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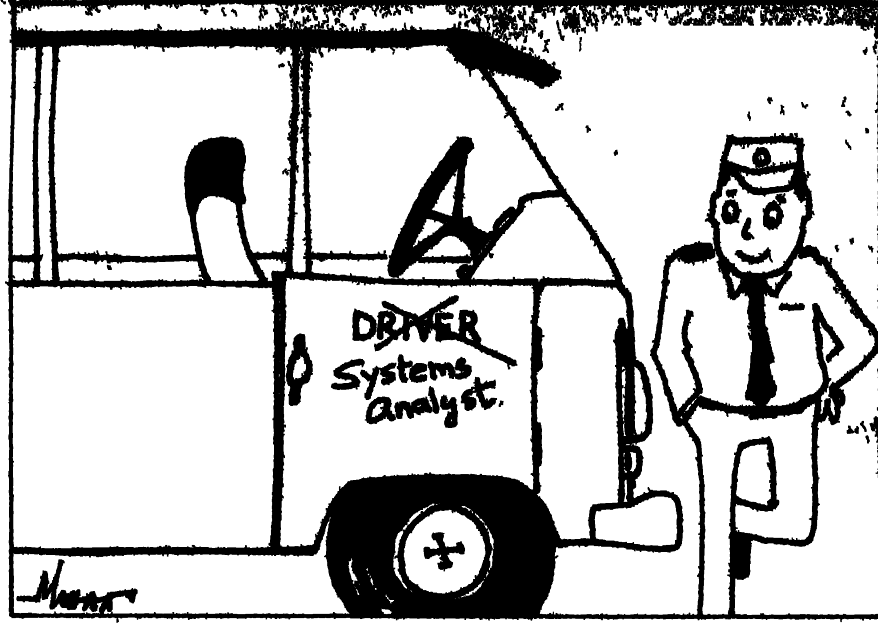
Tricksters do not do it with cold hands

CARD-SHARPERS and tricksters in fiction are often depicted with cold, clammy hands. Though icy fingers may add a sinister touch to the plot, they are inconsistent with villainous behaviour. Cold hands, in fact, impair manual dexterity. Why is this so?

The answer lies in the fact that hands have a relatively large surface area to volume ratio and so are particularly susceptible to cold. Under cold conditions, finger sensitivity or dexterity is much reduced.

Scientists at the National Building Research Institute, Pretoria, South Africa, investigated the differences between various groups (men and women, whites and blacks) in their performances with cold fingers. Subjects wore normal factory gear (boiler suits for men and lab coats for women) over their everyday clothes.

They were made to tie knots, thread blocks, screw nuts onto plates and insert cylindrical pegs into holes at temperatures 6°C, 12°C, 18°C and 24°C. Their finger skin temperatures (FSTs) were recorded by means of thermocouples taped to their middle fingers. They found that at air temperatures below 24°C, whites tend to have warmer fingers than blacks. At an air temperature of 6°C, whites performed at 87 per cent of their performance at 24°C whereas blacks showed the same per cent performance at 12°C. White females retained the highest dexterity among the groups followed by white males, black females and black males.



Buses get computerised

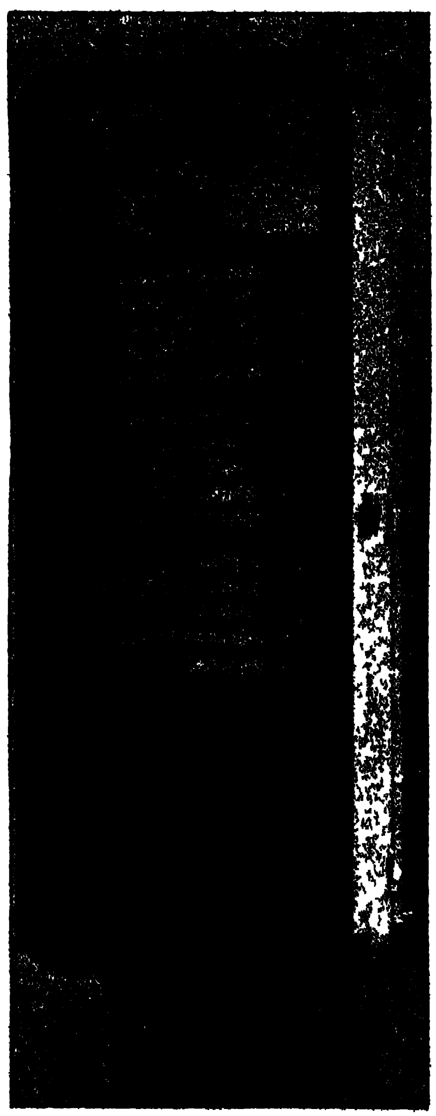
THE inhabitants of Caen in France need no longer be impatient waiting anxiously for their bus every day Thanks to microchips, the bus has become an ideal means of transport

The central depot of the CTAC (the Transport Company of the Caen Area) has been equipped with an extremely sophisticated computer system called "Alex" Alex's brain never stops thinking, calculating, seeing and foreseeing. The buses, fitted with microchips, can be monitored from a central station.

Since Caen's buses got their microchips, the busdrivers' procedure has become a ritual. Every morning they take a black cassette into their buses and put it into a sort of console near their steering wheel. Then they hear a voice giving details about the daily routes of all the lines. The different phases of the routes are visually reproduced on a small screen near the microchip.

Also, every driver knows if he is behind or ahead of schedule, where the next stop is, and what alternative routes to take if there is too much traffic. The microchips can also diagnose mechanical faults, and, with a system linked to the step, even record the number of passengers who get inside the bus. Each stop is fitted with a "Top Alex", which is a computerised panel linked to the central station, so that one can know the arrival and departure of the next bus, at any time.

—Christiane Falgayrettes



"Top Alex": The electronic indicator fitted at every bus stop

New chemicals found on comet

COMETS are believed to be as old as our solar system which is nearly four billion years old. They are said to originate in a large spherical cloud surrounding the solar system (Oort cloud), where they are present as fragments of ices (frozen gases) and dirt. Once they enter the solar kingdom, sunshine vaporises the ices, the mixture of gases and dirt forming the familiar glowing tail. The compact region which holds the solid matter is called the cometary nucleus.

Astronomers are trying hard to figure out the chemical composition of comets. Though comets were formed at the same time as the solar system, they were not subject to the treatment that the latter

was, the comets keep a good record of the conditions that prevailed in the early times; hence, they could tell us more about our origins. So astronomers, eagerly await a comet making its cosmic round to find what chemicals are present in it."

A variety of telescopes are used for this purpose—infrared, radio optical, and ultraviolet. As a result, a number of chemicals have been identified: atoms of carbon, oxygen, hydrogen, diatomic molecules of carbon-hydrogen, carbon monoxide, water, silicates; metals such as sodium, potassium and calciuum, etc.

The comet IRAS-Araki-Alcock as observed from the Asiago Observatory, Italy

Not all chemical species reported have been conclusively shown to be present, however.

Comet, IRAS-Araki-Alcock, the fourth to enter the solar system in 1983, caused quite an excitement as it offered a unique opportunity for cometary observers. It came closer to us than any other so far (at its closest, on May 12, 1983), it was almost 4.5 million km from the Earth, little more than 10 times the distance to Moon. The comet was first identified as a moving infrared object by the Infrared Astronomical Satellite (IRAS) and was later discovered independently by two amateur astronomers, Genichi Araki in Japan and George Alcock in England. The numerous observations made during its brief sojourn have yielded considerable new information on cometary composition.

Scientists of Max Planck Institute in West Germany have shown, conclusively, the presence of water and ammonia from their radio observations. Scientists from the University of Maryland, USA, came out with evidence for the presence of sulphur dimer (never seen before) from experiments conducted with the International Ultraviolet Explorer Satellite. The sulphur molecules, confined to a region close to the nucleus, could have been formed, they say, by the irradiation of other sulphur-containing species in the ices.

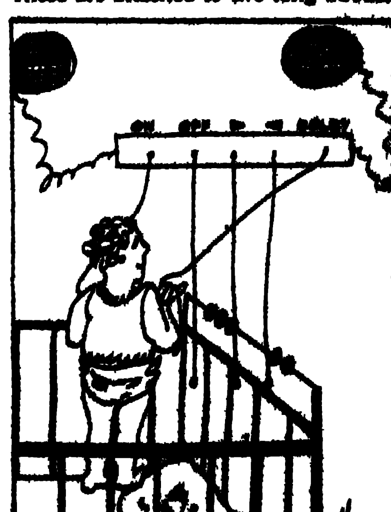
Using optical telescopes, astronomers from the Asiago Astrophysical Observatory in Italy, have photographed the comet (see fig.) The spectroscopic analysis of the visible spectrum has revealed many new molecules. Nearly 450 lines have been obtained but many are yet to be analysed. The presence of ionised hydrogen sulphide and aldehyde (HCO) have been established for the first time in the visible spectrum (never observed before on any astronomical object). They also have in their suspect list formaldehide, molecules of deuterium-carbon-oxygen (DCO). NH_4. IRAS-Araki-Alcock has, in short, given a big boost to cometary chemistry.

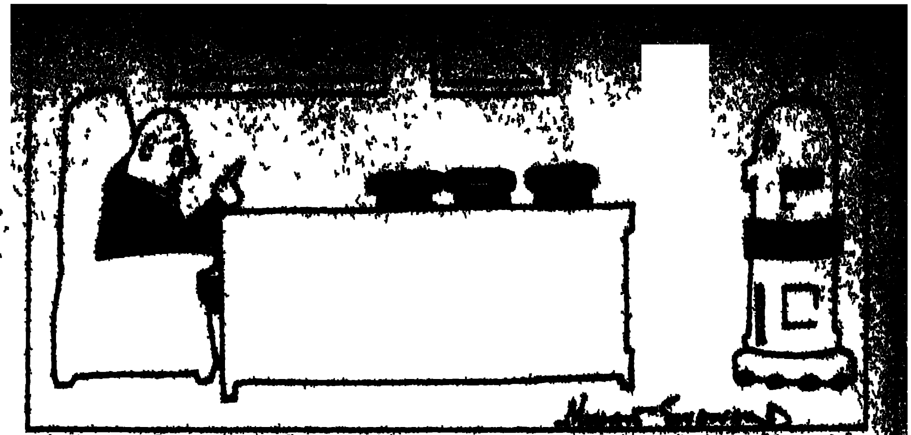
Babies prefer Beethoven

A HUSBAND—wife team, Dr. Tom Troscinko and Dr. Sue Blackmore, have devised a special cassette player to put small babies to sleep. Perhaps soon parents of babies may look forward to peaceful nights with no walls or cries from their young ones!

It all started with the doctors' own baby girl Emily. At birth Emily was exposed to tape-recorded 'baby soother' sounds in the hospital. This gave them the idea to conduct experiments on the type of sounds that babies preferred. The parents devised a cassette player operated by pulling a cord; little Emily mastered the technique in 10 minutes at the age of four months!

The baby-operated tape player has two cassette players, a small stereo amplifier, car loudspeakers and a microswitch circuit. Two arms with microswitches extend about 20 cm over the cot head. These are attached to two long wooden





"And remember, Mssrs RoboTeach Placements Ltd sent you here. Any trouble and you'll be giving a very bad name to Mssrs RoboTeach Placements Ltd."

Finding the right robot for the right job

ROBOTEACH is the first computer system which chooses the correct robot for a specific industrial task. It has been developed by Robert Tilove and Mary Pickett of the Computer Science Department of General Motors, USA.

Tilove and Pickett concentrated on robot programming languages which specify desired robot motions. These languages have a serious drawback. They cannot take physical obstacles into account nor can they anticipate collisions as they have no way of describing the robot's environment.

RoboTeach, provides computer the representations of the environment, the robot and the task, without wasting any time and money in testing such a system for feasibility. It can compare the representation of a task with the representation of any robot and select the best robot for a particular task. Once a robot has been selected, RoboTeach can be used to program it for work.

handles with rings which can be easily handled by babies The baby, lying on its back, can easily grab the ring and thus operate the cassette player To play both cassette players simultaneously is impossible as pulling on one handle automatically disengages the second player. And the baby must continue to hold the handle for music to continue.

In a few trials carried out on babies between seven months and two years using three types of music—baby-soothing sounds, nursery rhymes and classical music, including Beethoven's Third Symphony—interesting results were obtained. Dr. Blackmore observes: "In one experiment, over a period of 24 days their tastes changed. At first they preferred the baby-soother music, then the nursery rhymes and finally were really 'hooked' on Beethovan. It would seem that though they like music that is familiar and predictable, this eventually bores them and they prefer something more complicated."

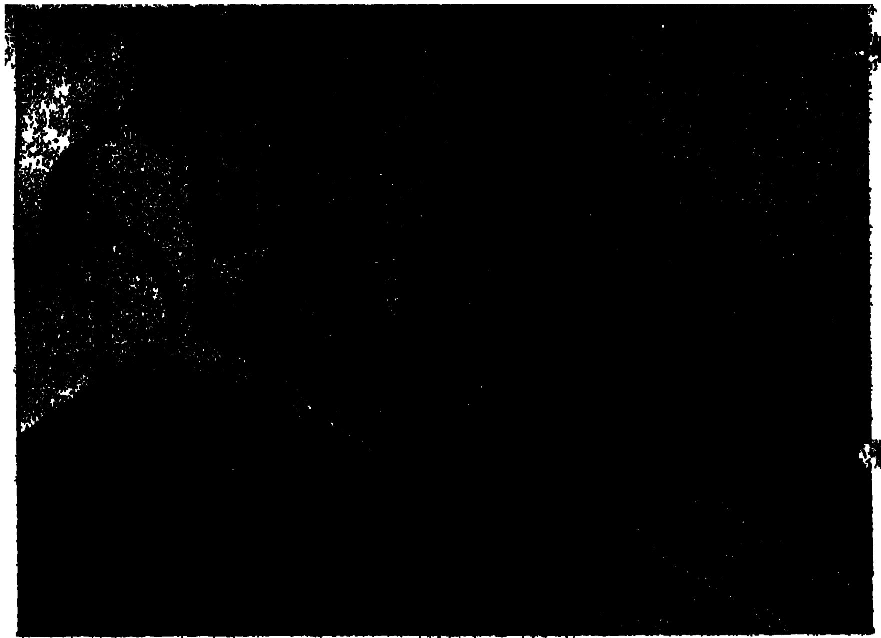
Now even microcomputers have been connected to the system. They monitor the number of times a baby 'plays' a particular type of music at different times of the day and night. Chances of commercialising such a 'sytstem' are high, with advantages to parents.

The big banger shoots kidney pain dead

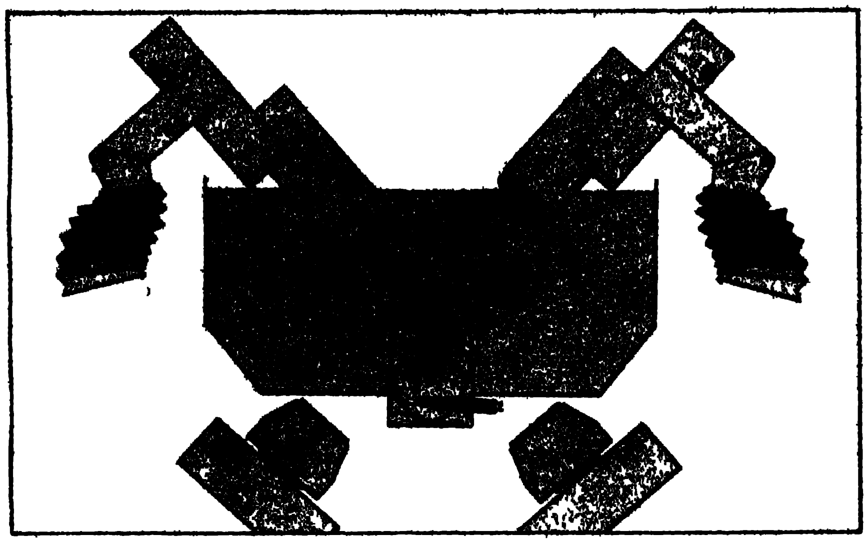
A MACHINE that shatters kidney stones is now in routine use in the Johannes Gutenberg University Clinic, Mainz, West Germany Known as the lithotripter, which literally means "making the stone flow freely", this revolutionary machine uses electronic shock-wave bombardment.

The idea emerged from military and aerospace research It was noted that American bombers disintegrated in midair during rainstorms. Laboratory studies later showed that the constant impact of rain drops on an airframe generated soundwaves that shattered brittle materials. In time the possibility of using soundwaves to break kidney stones was investigated and the lithotripter was the result.

During the lithotripter tr-¿atment, the patient is immersed in a metal bath of ionised water. Two X-ray television cameras (left and right) scan his rib-cage and abdomen to locate the kidney stones. The surgeon can then train his shock-wave gun-lights on them, ready to blast



The kidney patient is strapped into position in the metal bath of ionised water for treatment



The two-axis X-ray system pinpoints the exact location of the kidney stone

The blasts are synchronised with the patient's heart beat which is measured by an ECG (electro cardiogram) machine The blasts are fired through an electrode at the base of the bath

The lithotripter treatment has several advantages over conventional surgery The maximum duration of a single treatment is 45 minutes, the patient can be up and about within four hours and can be discharged after three days. The harmful effects are negligible and the maximum blood loss is about 20 cc. Surgery entails a 14-day hospital stay, followed by a month for convalescence and the possibility of wound infection, immobilisation, blood loss of upto four litres and considerable pain. Besides, repeated surgery destroys the kidney.

Kidney stones can be formed through an excess of uric acid in the system. They occur either as densely packed balls of calcium—some even as large as a grape fruit, or as antler-shaped 'staghorn stones' whose branches fill several kidney tubules. They are impossible to flush out since they are likely to cause blockages that could inject or permanently damage the kidney.

(Asia Features) —Bill Spicer

A sweaty problem

FOR many, excessive perspiration is an embarrassing problem with smelly feet, rotting shoes and ruined shirts and dresses. If for some the sweat glands

become over active due to hot weather or strenuous exercises others sweat profusely without any trigger.

There are not too many treatments available though. In the UK the most commonly used is a solution of aluminium chloride hexahydrate in alcohol. It is applied to the underarms before going to bed. A possible side-effect of this treatment is that the skin may suffer sores due to the acidity of the solution.

Tablets containing atropine may be useful to those who sweat in their hands and feet. The drug slows the activity of the glands. But it also has side-effects like stomach upsets, dry throats and mouth, and blurred vision.

A technique known as iontophoresis may also be useful. A low-level electric current is passed into the skin which plugs the glands and avoids the sweating.

As a last resort sufferers can also opt for surgery. Skin in the armpit containing the largest concentration of sweat glands may be removed. Other alternative is the severing of nerve supply to the armpits.

New drugs to treat diabetes

DIABETIC patients need worry less now as drugs, other than insulin, are on their way.

Experiments conducted by Douglas Coleman and his colleagues at the Jackson Laboratory, Bar Harbour, USA, (Endocrinology, 115, 1, 1984) have shown that certain sex-steroid metabolites prevent diabetes in mutant mice. These mice, which are prone to obesity and adult-onset diabetes, serve as good models for tests.

Diabetes in humans is a result of a hormonal imbalance on ageing. This can now be corrected by dietary hormones or metabolites. The researchers found the two metabolites of dehydroepiandrosterone—3α and 3β hydroxy etiocholanolone—very effective. These were able to prevent the degeneration of insulin-producing pancreatic cells and avert diabetes.

Space age tooth cap

WHEN Ralph B. Sozio of the Harvard School of Medicine, USA, wished for a crystalline crown as opposed to a golden one, he wasn't

Which tooth alone wears a false cap?

referring to kingly headgear. He simply wanted a cap for his tooth!

Sozio found that traditional all-metal porcelain or porcelain-metal crowns had certain drawbacks and he turned to the ceramic industry for better ideas. He found his 'crown', in the form of a crystalline, high-alumina ceramic, which was originally used to meet "space age" needs in electronics and other industries. Known as Cerestore Crown, the material is made by Coors Porcelain Company and introduced by Johnson and Johnson Dental Products Company. It has a precise fit, natural look, is exceptionally strong and highly resistant to heat and cold. In the figure above, the tooth second from the left wears this crown. An added advantage is that it does not block dental X-rays as metal-containing caps do.

Environmentalists score on nuclear waste dumping

FOUR years of legal struggle between the University of California at Los Angeles (UCLA) USA, and the Committee to Bridge the Gap (an antinuclear, environmental group) has led to the decision of dismantling the UCLA research reactor. Attempts to renew the licence of the reactor have failed.

The Committee in its legal arguments claimed that "the reactor posed unacceptable risks as a potential source of radiation and a target for terrorist attacks". Daniel Hirsh, president of the Committee has put in hard work to impress on all the universities to initiate steps to "improve safety and security measures". He has further lobbied for switching from high-enriched (bomb-grade) fuel to low-enriched uranium in all university reactors.

UCLA authorities, however, claim that the reactor was being closed purely for economic reasons, not many nuclear engineering students or faculty members were using it. One professor cannot justify the high cost of operation. Over a period of next five years, the reactor will be dismantled at a cost of $300,000 to $ 1 million.

Environmentalists have scored a victory on another related front too—the disposal of radioactive nuclear wastes. The US Navy was recently forced to abandon a plan to dismantle and dump some 100 obsolete nuclear submarines off the California and North Carolina coast, because of pressures from environmental groups, the California State legislature and the US Environmental Protection Agency. Now the Navy proposes to bury only the reactor compartments at low-level waste sites at government facilities in Washington and South Carolina.

Though the spent fuel from the submarine reactors was to be removed by the Navy, the environmental groups voiced fears of possible movement of radioactivity from the submarine parts to marine life. Submarine parts would have made oceans a dumping-site for low-level radioactive wastes, especially when sea-dumping has been abandoned by the US in 1970.

Can you explain this phenomenon?

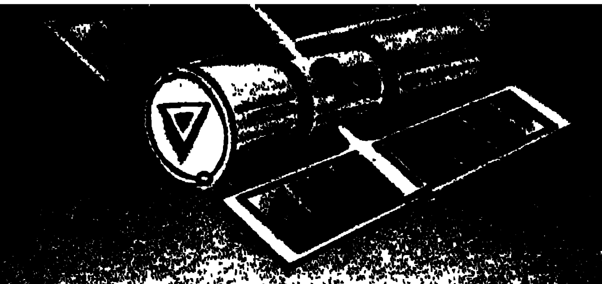
TWO school-going children, Nitya G. and Hema G., from Anushakti Nagar, Bombay, have sent in some interesting information. They say when they click their finger nails or crack knuckles under still water in a big plastic bucket, a distinct metallic sound is produced.

"The same dull, non-metallic sound, buddy. You can come out now."

They made sure that the sound was not produced by any metallic vibration by removing the handle of the bucket. The larger the volume of water, the more metallic and impressive was the sound.

They also clicked metallic tongs under similar conditions and found that the metallic sound was produced only if a portion of the tongs were outside water. When the tongs were entirely dipped, the sound was dull and non-metallic.

Any explanation?



HARNESSING THE SUN

For decentralised requirements of heating, lighting, pumping and other uses, solar energy has immense possibilities. What is the status of this technology? Beginning a new series **(see next page)**

HARNESSING THE SUN

R. L. Datta

In a remote village in Bihar, tribals draw water using solar pumps. Near Bangalore, a railway station is run on solar cells. Large hotels and industries in cities use solar energy to heat water, and so on

Despite such sporadic bright spots across the land, the solar energy scene in India is still dim, or is the Sun just rising over the energy scene? Future developments—both technological and economic—will decide.

Why solar energy? India has a high intensity of solar radiation for much of the year in many regions (on an average, 550 calories per square metre per day). It also has vast arid and semi-arid areas and a high percentage of the population living in widely dispersed rural areas and which is avers to sophisticated technologies. In the rural areas, covering over 466,000 villages, the essential requirement for energy is for cooking, lighting, water-pumping, drying of agricultural products and their transport; though mainly farm-based, small industries are slowly emerging in these areas, needing some power, locally produced.

To obtain this energy for rural areas, at least 20 million tonnes of coal and 2.5 million tonnes of oil are burnt every year besides the use of a huge quantity of electric power. Much of this energy requirement is at temperatures below 200°C. Such energy, in most cases, can be obtained from renewable and sun-derived sources, while the large power needs of the urban areas can be fed from the national grid by increasing conventional power generation. This will go a long way in conserving our scarce resources like oil. More important, it will reduce the relentless pressure on forests for fuel-wood. And, with increased use of such renewable energy, agricultural and scattered small-scale industrial development could be spurred in rural areas.

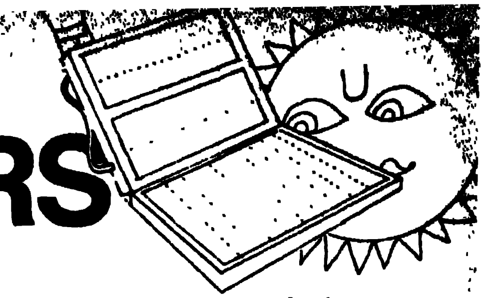
In general, solar energy can be put to a variety of uses—heating water, cooking, drying crops, pumping water, desalination of water using solar stills, refrigeration, heating and cooling of houses, mechanical and electrical power production, conversion of agricultural wastes into energy (biomass conversion), energy plantations, etc. Of the three main solar energy conversion processes, thermal conversion(converting into heat, for example, for heating water, cooking, drying and low-temperature production) and biomass conversion seem to be on way to making a dent; conversion of solar energy directly into electricity (using photovoltaic or solar cells), although technologically feasible, has still to go a long way to be economically viable.

The problem with solar energy is that it is too diffuse and intermittent. Devices to collect and concentrate it are, therefore, crucial, and so also devices to store it for use and materials with desirable radiative properties for making solar gadgets. Though extensive developmental work has been done in India and other countries on collectors and concentrators, storage devices and materials development are the weakest links.

Dr. Datta, who has been for long associated with research and industries relating to solar energy applications, is a member of the UN expert group on non-conventional energy sources.

Status Of Some Solar Technologies

Application (with technologies used)	Status
AGRICULTURE	
Irrigation pumping, using solar rankine, sterling engine, solar cells, biogas engine and windmills	Except windmills, others are expensive now. Require R&D to improve materials, collection and storage problems.
Drying (Solar collectors and chambers)	Mirror-boosting with drying to be extended to tea, tobacco, timber and all kinds of foodgrains.
Food stroage (Solar refrigeration, solar cells, wind generators, biogas engine)	Feasibility established and substantial R&D required to increase efficiency of performance of low-temperature devices.
Fertiliser/fuel (Bioconversion)	Works reasonably well. Studies to improve quality and quantity of gas
INDUSTRY	
Heating and cooling. (Collector, concentrator, selective surface)	Limited uses, for houses, hotels and industry. R&D for honeycomb collectors, solar pond, concentrating collectors of refractive and reflective optics, mirror booster, vacuum tubes
Process heat for industries (As above)	Being used for low-pressure steam upto 120°C temp, and in laundry, textile, dairy industries. Possible uses for milk pasteurisation, sterilisation, pharmaceutical and chemical industries. Hot water and hot air (say 110°C) systems and higher pressure steam are to be developed
Power production (Solar Rankine, sterling engine, solar cells, biogas engine and wind generator)	Except windmills, others are very expensive.
Salt and marine chemicals (Salt and marine chemicals recovery technologies)	Being used extensively. Optimised design of salt farms for better use of solar energy needed, use of green dyes, efficient production of mixed-salt for marine chemicals recovery



WATER HEATERS

H. P. Garg

OF all the commercial uses of solar energy, heating water is the only one that is economically viable. Solar water heaters find wide applications in large establishments like hotels, hostels and hospitals, industries such as textiles, paper and food processing, in homes, and even in heating swimming pools in winter.

Work on solar water heaters has been in progress for nearly a century now. Over 30,000 solar heaters had been installed in the US by 1950 but as cheap energy from fossile fuels became readily available, their popularity began to decline. Rapid technical advances in the last 30 years have made solar water heating viable again, and the obvious benefits can no longer be overlooked where the climate is ideal, particularly when the energy shortage is getting acute. Simple to construct, they need almost no running and maintenance cost, and are competitive with electrical water heaters. And they can be fitted into existing houses.

Initially, of course, a solar water heating system may cost four to six times higher than a system of the same capacity working on electricity, gas or other fuel, but over four to six years this is more than offset by savings in the cost of operation and maintenance

To heat water with solar energy, you need to trap and collect that energy and convert it into heat. For heating water, it is not economic to concentrate solar radiation because the mechanism required to follow the Sun through the year is complex and costly. Almost all solar water heaters are, therefore, based on flat-plate collectors—generally metallic or plastic plates (with tubes on them) which absorb the solar radiation and heat water or any other fluid flowing through the tubes. The plate is covered with transparent or translucent glass or plastic which helps retain heat by reducing heat losses from the plate; the cover lets in shortwave light radiations (0.2-2.5 micrometre wavelength) from the Sun but does not allow the longwave (4-40 micrometres) heat radiations reradiated from the absorber plate to pass through it, trapping them inside (the 'greenhouse effect'). The plate may be polished or painted black or otherwise suitably treated to increase heat absorption and also insulated at the side and the black to reduce heat loss (see box on p.22).

Many variations and sophisticated systems can be built on this. And much pioneering work has been done in the USA, the UK, Australia, South Africa, Israel and India. Depending on their applications, range of temperature and capacities, solar water heaters can be grouped into four:

(1) Swimming pool heater where the temperature rise is very low and where a simple plastic collector can be used even without any cover and insulation.

(2) Built-in-storage heater where the temperature ranges from 40°C to 60°C and where solar energy collection, water storage and water flow control functions are combined into a single unit.

(3) Domestic heaters where the maximum temperature required is no more than 80°C and the collector and storage functions are separated; the storage tank being placed higher than the heater, water circulates naturally by the temperature difference between the cold and hot water. While this thermosyphon system is largely self-controlling, its capacity is usually limited because of the rather weak thermal gradient.

(4) Large heaters for community and industrial use where a large number of collector banks (Fig. 1) are used. We shall discuss each of these.

Since a very large volume of water is to be heated in a swimming pool, heating with fossil fuels, natural gas or, electricity is very expensive and, in some countries, prohibited. Much heat is lost by evaporation from an open swimming pool which can be prevented if the water surface is covered by a thin transparent plastic sheet. In large swimming pools, a mechanical roller system may be used to remove and replace the cover. A double-layer plastic cover with an air space between the layers is becoming popular abroad. Such covers raise the pool temperature

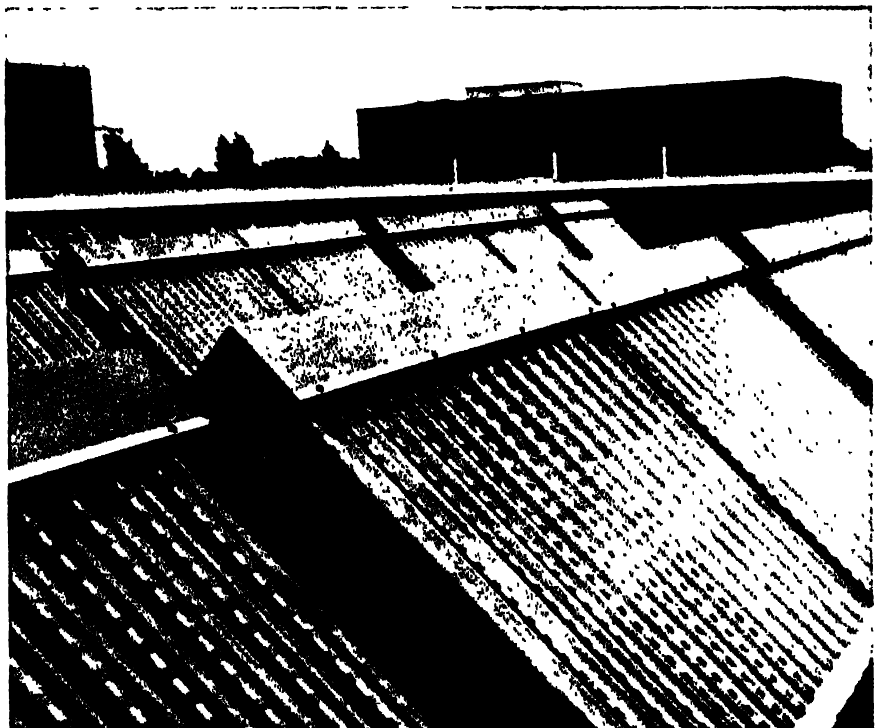


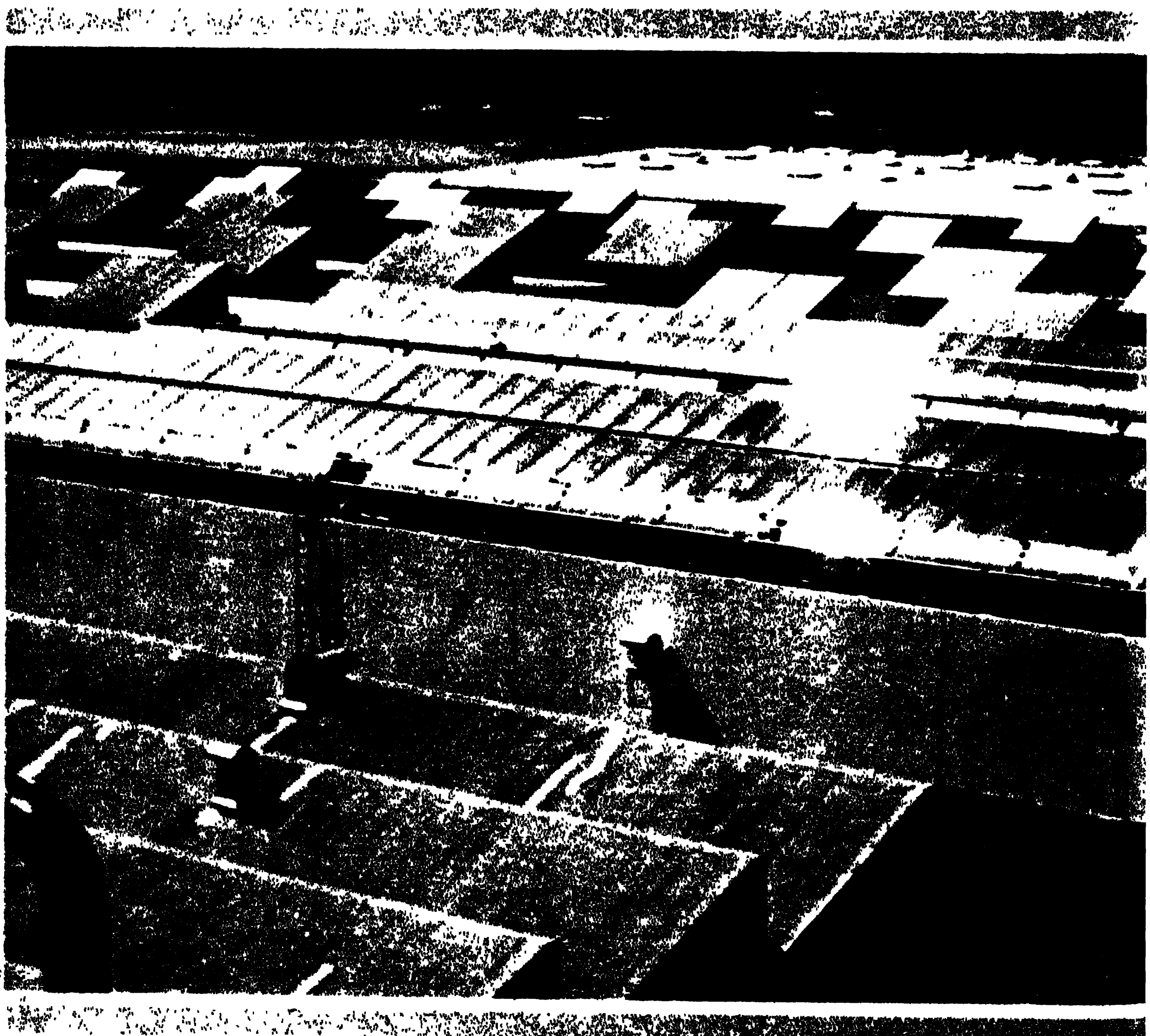
Fig. 1 Flat-plate collectors

by 5°C to 10°C. Since the temperature rise neded is very low, simple low-cost collectors (generally rubber or plastic panels) without any cover and insulation are also used. The collector is placed between the filter and the pool. When there is enough sunshine, the filtered pool water is circulated through the collector tubes where it is heated by solar radiation before it returns to the pool. All the water in the pool may be circulated through the filter once about every 5 to 10 hours. Alternatively, the solar collector and the pool cover can be combined and floated on the water. Such floating heaters are now being marketed.

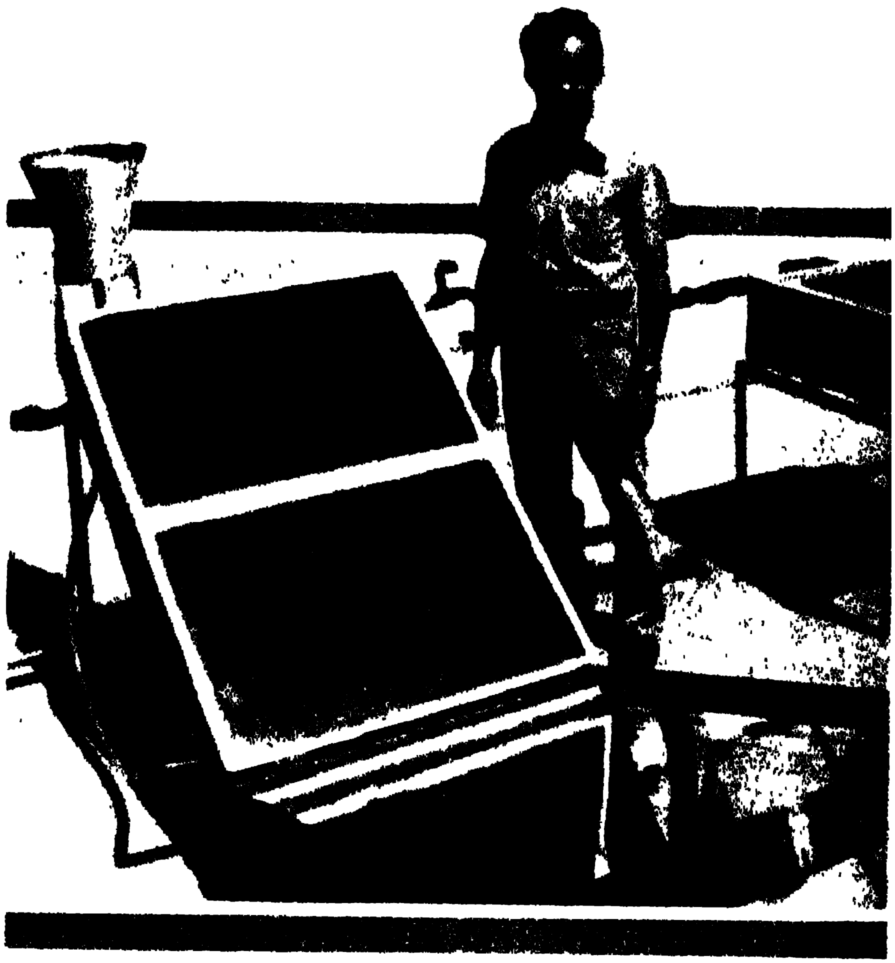
Built-in storage heaters

The collector in a built-in storage heater absorbs solar radiation as well as stores hot water and there is no separate storage tank. Simple and low in cost, these heaters can provide hot water only during day. Among such heaters are the shallow solar pond water heater, built-in storage heater and other low-cost heaters.

The shallow solar pond heater (Fig. 6) is essentially a pillow-like plastic water bag, normally 4 to 15 cm deep, with transparent plastic at the top and black plastic in the bottom; it may have



insulation built in the bottom or can be placed on an insulated platform. Solar radiation falling directly on the water heats the water, peak water temperatures ranging from 40°C in winter to 60°C in summer; the solar energy collection efficiency is directly proportional to the water depth. Several thousands of such heaters are in use in Japan, particularly in rural areas. In the USA, large-size plastic shallow solar



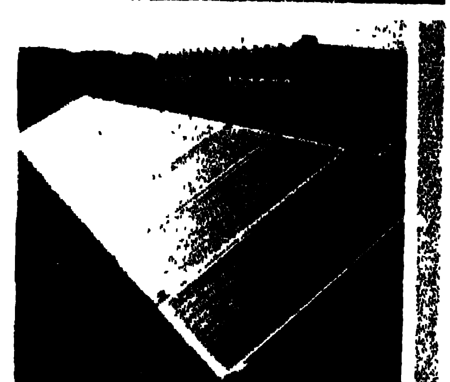


Fig. 2 **(left)** *A forced circulation solar water-heater installed in the USA*

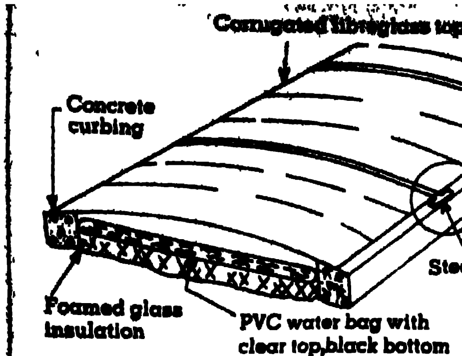
Fig. 3 **(top)** *Built-in storage heater with a mirror booster. Hot water flows out from the top when the gate valve on the inlet pipe is opened*

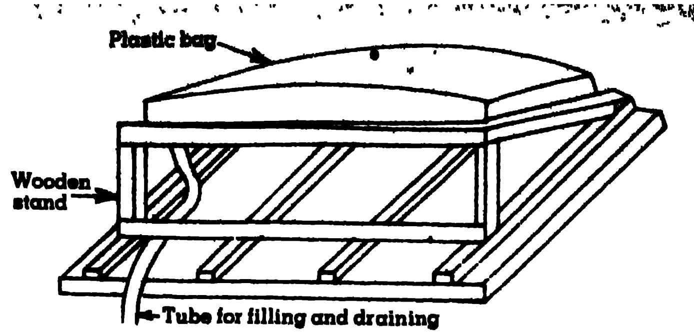
Fig. 4 **(above, left)** *A domestic solar water heater. The storage tank is at the top*

Fig. 5 **(above, right)** *An industrial water-heating system. It has a capacity of 1000 litres per day*

pond heaters are made and hot water supplied to industries.

Because shallow solar ponds or open-type solar water heaters can only be placed horizontally, they work poorly in winter (due to the low altitude of the Sun) and at high altitudes. So completely closed heaters (Fig. 6), made of either a rectangular metal sheet or several closed large-diameter metal, plastic or glass pipes, are preferred which could be tilted to capture more solar radiation. Such closed rectangular box-type solar water heaters (Fig. 4) have been extensively studied in India by the author. For rural use, where there is no central water supply





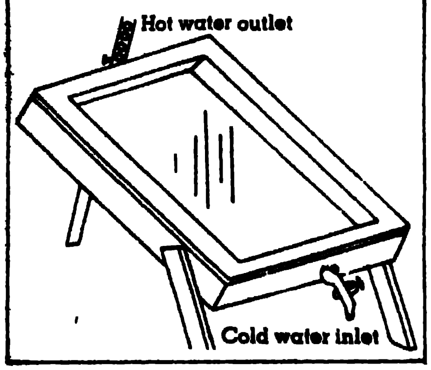


Fig. 6 Some built-in storage water heaters: shallow solar pond* (above, left) *plastic pillow water heater* (above, right) *and tilted water-heating tray with glass cover

arrangement, a large funnel can be fixed at the top of the heater and connected to the inlet tube. Hot water can be taken out immediately by putting the same amount of cold water in the funnel. The water gets hottest, about 50°C, around 5 pm and then starts cooling. Therefore, this type of solar water canot be used in the night.

Hot water can be stored in the heater during night by covering the heater with about a 5-cm thick insulation blanket at around 5 pm till the next morning, or draining the entire hot water from the heater into a separate insulated hot water storage tank, or providing an insulated baffle pattle in the rectangular tank (a simple plate of some insulating material which divides the water tank and reduces heat losses from the lower side to the upper side) or providing a honeycomb structure (made up of specially designed sheet of thin transparent material such as glass or plastic) between the absorbing plate and the glass cover which reduces convection losses to the outside considerably. Built-in storage heaters are not generally preferred because they cannot provide hot water in the morning and their temperature range is limited.

So more than 90 per cent of the solar water heaters used around the world have separate collectors and storage tanks. In a conventional domestic water heater, cold water from the feed cistern is passed into the collectors where it is heated by solar energy. The water then passes to the hot water cylinder which is heated by a boiler (solid, gas or oil-fired) or an electric heater. Generally, the heater is within the storage tank itself, thus saving one cylinder. A temperature sensor in the middle of the tank controls the temperature and activates the heater when necessary. In hot weather or tropical countries, auxiliary heating may not be required.

Several designs of solar water heating systems are possible, and no common design can be recommended for use in all situations. Some of the solar water-heating systems are: direct natural circulation thermosyphon system, indirect natural circulation thermosyphon system, indirect forced circulation system, direct forced circulation system, single cylinder indirect forced circulation system, and indirect system with air-heating collectors. Some of these are shown in Figs 7 and 8.

Natural circulation systems

In a natural circulation or thermosyphon type heater, the storage tank is placed at a certain height (30 to 60 cm) related to the top of the collector to prevent reverse circulation during off-sunshine hours. In the morning, the sun heats the collectors, the hot water inside rises by natural convection and reaches the storage tank and the colder storage tank water leaves from its bottom and flows into the collectors. Thus water circulation is naturally and automatically established whenever there is enough sunshine, and stopped

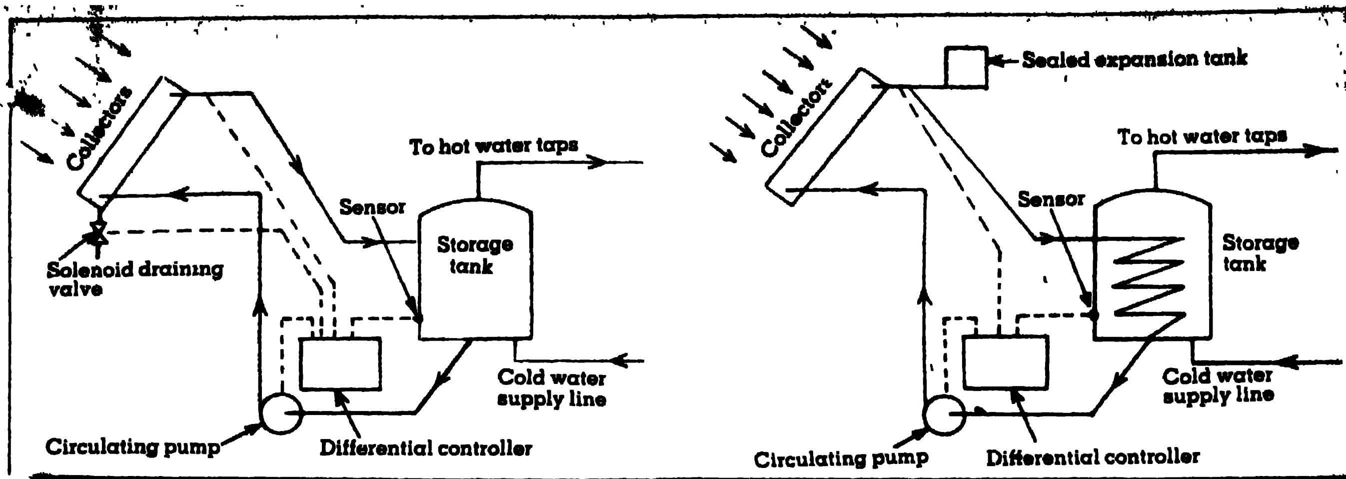
Components of a water heater

SOLAR water-heating systems consist of flat-plate collectors, storage tank, heat exchanger, automatic controls, and pumps, pipeworks, valves and fittings.

The purpose of the collector is to absorb the radiant energy of the Sun and transfer this energy to the liquid flowing in it. There are a variety of flat-plate collectors but a tube-in-plate type collector is generally used; it may be metallic or plastic with single or double cover and selectively coated or ordinary black-painted, depending on the temperature of operation and climatic conditions. The absorber plate may be copper, aluminium, steel, stainless steel, plastic or galvanised iron, often plated, painted, or chemically treated. The tubes may be copper, aluminium, steel, stainless steel, plastic or galvanised iron, and the fluid may be water, air, water/glycol, antifreeze mixtures, oils or silicone fluids.

The storage tank (made of copper, steel, galvanised iron, aluminium, concrete, plastic or even wood) stores the water heated during day for use when needed. The tank should be sized to hold between 1½ and 2 days' supply of hot water. Electric or gas booster auxiliary heating arrangements are made; the thermostat should be in the middle of the tank, not in the bottom.

As for water flow control systems, in thermosyphon-type heaters, where pumps are not used, there is no need of any control system. In a forced circulation or large solar water heater, a control is required whose primary purpose is to 'turn on' the pump only when heat can be gained and 'turn off' when heat cannot or should not be collected. Several types of controls are proposed and used: time-switch control, temperature or radiation-dependent control, differential control, proportional control, etc. Generally, an electronic differential controller is preferred which operates the pump at a predetermined temperature difference between the hot water storage tank and collector outlet temperature.



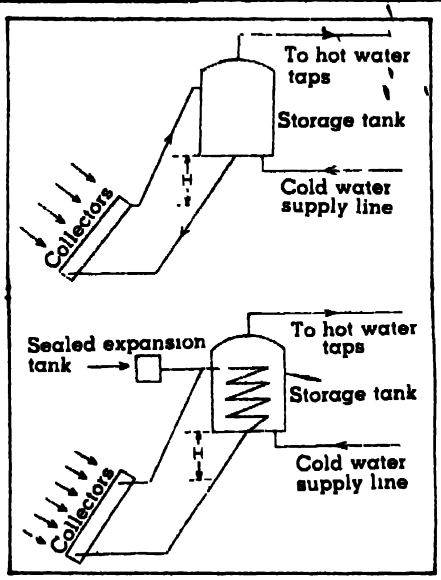


Fig. 7 (right, top) Direct natural circulation or thermosyphon system of heaters. (Right, below) Indirect natural circulation system

Fig. 8 (Above, left) Direct forced circulation water heater and (right) indirect forced circulation heater.

when it is insufficient. Such a natural circulation system may be direct or indirect. In a direct system, the potable or service water is directly circulated between the hot water storage tank and the collectors; in an indirect system, a fluid (such as anti-freeze solution, air, distilled water, or a heat transfer oil) other than the potable or service water is circulated in the collectors. A heat exchanger transfers the heat to the fresh water in the storage tank. This protects the collectors from damage from freezing in very cold climates. In a forced circulation system, either direct or indirect, water is circulated by a pump. The main advantage of a forced circulation system is that the storage tank can be placed at a convenient location like in an attic or a bathroom.

Collector orientation and tilt

Collectors should always face the equator, that is, true south in the northern hemisphere, such as in India and true north in the southern hemisphere such as in Australia. Variations of 20 degrees east or west of south (in the northern hemisphere) or north (in the southern hemisphere) are acceptable. If the heater is to be used in winter season, the collector tilt from the horizontal should be equal to the latitude (L) of the place plus 15 degrees $(L+15)^{\circ}$. For summer and year-round use of hot water, the collector tilts can be approximately $(L-15)^{\circ}$ and 0.9°, respectively. A few degrees of variation in the tilt will not affect the performance significantly, though. A square metre of collector area can heat 50-70 litres of water upto 55°–60°C.

Large solar water-heating systems can also be used for space heating and cooling in houses. Several such systems are being used in the USA, Germany, Japan, etc. Here flat-plate collectors are used to heat water which delivers its heat, if sufficiently hot, directly to space either through radiant panels or liquid-to-air heat exchangers. If the water is not hot enough, the auxiliary heaters and used. A more sophisticated but dependable system is the one which can supply hot water as well as heat and cool the space as and when required. The Furukawa Electric Co., Japan, has developed such a system.

In India, the direct natural circulation thermosyphon system as shown in Fig. 7 is used for domestic purposes. Here the hot water can be used for bathing, washing clothes and dishes, etc but not for cooking and other kitchen purposes, since it may be contaminated. Where hot water is to be used for kitchen purposes, indirect systems using heat exchangers such as shown in Fig. 8 are recommended.

A domestic solar water heater of 150 litres capacity, heating water upto 60°C with copper tube collector, costs around Rs. 4000. A 10,000-litre-per-day industrial solar water heater, upto 60°C, costs about Rs. 5.5 lakhs. The Government of India offers subsidies to encourage use of solar water heaters for domestic, industrial and agricultural applications.

But solar water heaters have not become popular for many reasons, the main being its high initial cost. The second reason may be due to the fact that hot water is required for bathing only during 2 to 3 months in winter and hence it becomes highly uneconomical for domestic purposes. For industrial applications, solar water heating holds high promise since hot water is required throughout the year and an industry can afford to invest the large capital if the payback period is 4 to 6 years. Recently a large number of industries have indeed shown interest in the installation of solar water-heating systems. Over 80 large solar heaters have been installed in India.

However, the quality is generally very poor There is no ISI specifications for such systems; even the collectors, storage tanks, etc, are not standarised from the performance or cost point of view. The user finds it difficult to get a solar water heater. Generally, he is not aware of its availability, its working and other advantages and limitations. He is also not quite sure that the system will work at all, as things stand today. ☐

Prof. Garg heads the Centre of Energy Studies, Indian Institute of Technology, New Delhi. He has been involved with solar energy studies, particularly water heaters, for nearly two decades.

COOKING BY THE SUN

H. P. Garg

Fig. 1 The National Physical Laboratory, New Delhi, was the pioneer in developing the focusing solar cooker. The paraboloid cooker (above) it had developed is made of aluminium sheet and anodised to protect against corrosion and to avoid loss of reflectivity.

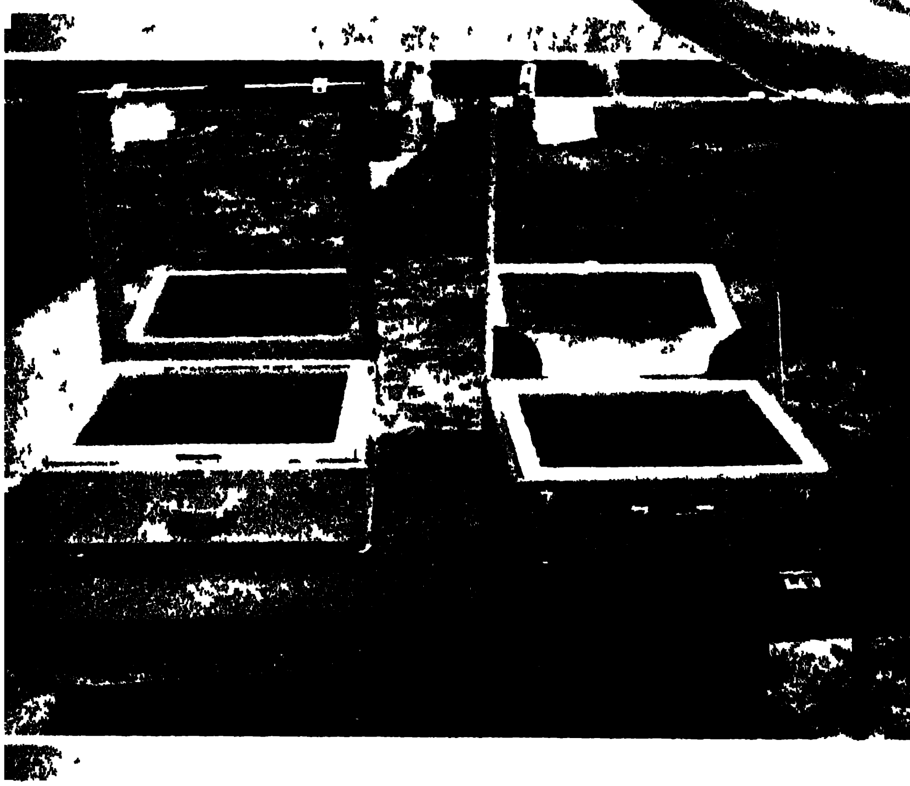


Fig. 2 (left) Hot box solar cookers with single reflector. The cooker takes about 2 to 3 hours to cook various dishes.

Fig. 3 (below) An improved solar oven, with 8 silvered glass mirror reflectors, 4 square and 4 triangular (see Fig 4). It reaches high temperatures, 250° to 350°C, and food can be cooked in 25 to 75 minutes.

PHOTOGRAPHS COURTESY H P GARG

IT is a simple technology which has received much attention but has found no success. Not yet anyway.

Much effort has been made in the last century to develop a solar cooker. And where such cookers have been demonstrated as in India, Morocco, Mexico, Haiti, Mali and elsewhere, they have been poorly accepted, mostly outrightly rejected. Though there are over 30 models of solar cookers around the world today, none could be mass used.

Why is this so? The reasons are several—economic, social, cultural and technical. Most of the solar cookers are expensive and beyond the reach of a common man for whom it is meant. Almost all cookers cannot cook food at night nor on cloudy days. Food has to be cooked outdoors. The cooker takes very long to cook and can cook a few dishes only. Finally, cookers now available are not dependable nor durable; they cannot withstand rough handling and though requiring frequent maintenance cannot be repaired locally.

If these problems could be tackled, solar cookers could come to be used widely. Indeed, properly designed and carefully introduced they represent a much needed appropriate technology for millions of people around the world. For commercial fuels like coal, kerosene, electricity and gas cost in-

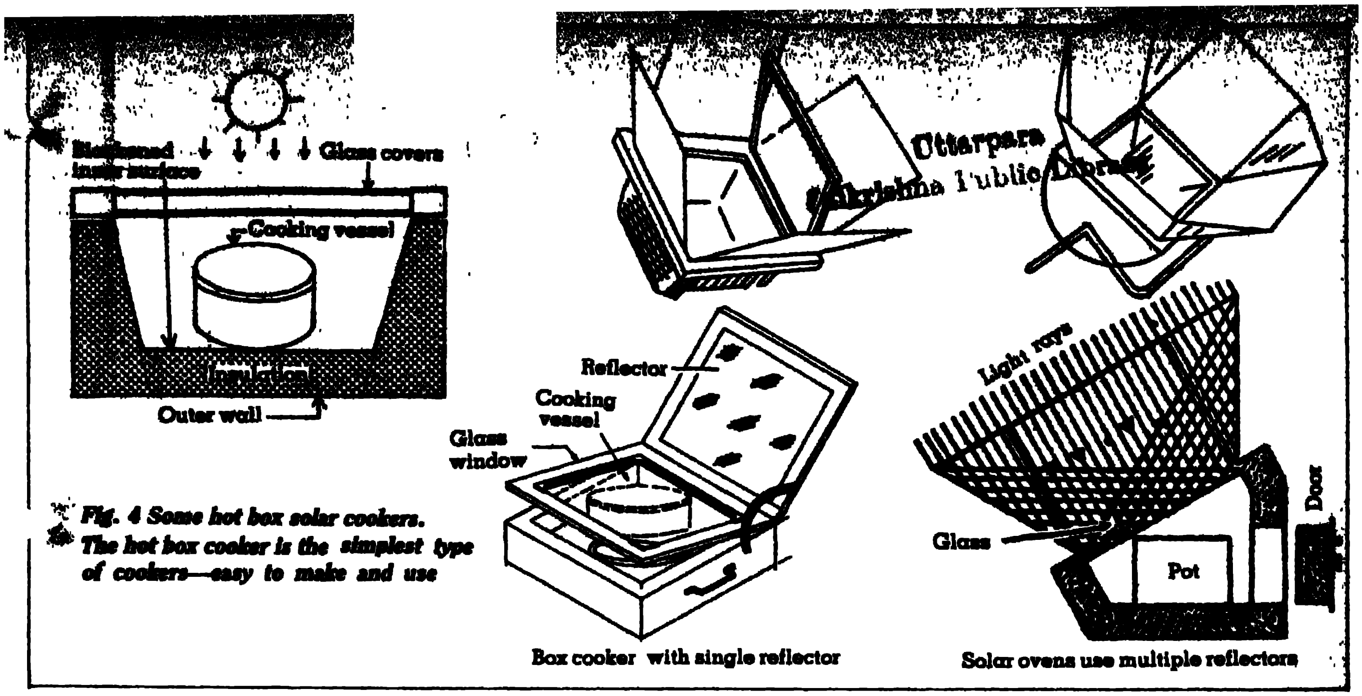


Fig. 4 Some hot box solar cookers. The hot box cooker is the simplest type of cookers—easy to make and use

creasingly high or are just not available; the over-exploitation of forests for firewood has caused extensive environmental damage (2000 million people are estimated to be short of fuelwood by the turn of this century, anyway).

But the point is, one must know who the intended user is, and look at technology development and adaptations from this perspective. Solar cookers are advocated for rural people who use firewood, agricultural waste and dried cowdung for cooking. These they get free, though at a great cost to the agricultural economy. Because of deep-rooted social habits and illiteracy, the practice will continue, unless the government intervenes. And this is possible only if some alternative means are provided.

Types of solar cookers

Solar cookers developed so far range from the simple hot box type to the sophisticated advanced hot plate type. These can be classified into three groups: hot box type, direct or focusing type, and the advanced type.

The box cooker is a double-walled box made from locally available material such as wood, metal dried bricks, cardboard and bamboo mat with some cheap insulation like dried grass, hay, straw, sawdust, grain chaff and cotton at the bottom and the sides and a double glass cover at the top to retain heat inside the box (by the greenhouse effect). The inside of the box is blackened to increase heat absorption and the cooker is placed in the open to receive solar radiation. The cooking vessel is kept inside the box. Generally, this type of cooker is used only for warming food but can sometimes be used for cooking food by boiling.

The performance of this simple box cooker can be improved by using a reflector, a sheet of polished or electroplated looking glass or aluminised plastic hinged to one side of the box, which reflects solar radiation into the cooker and enhances its energy input. Several reflectors, either collapsible or fixed, are used on all sides of the box for a solar oven (Fig. 3). Some box cookers are shown in Fig. 4.

A typical box cooker is the single-reflector cooker now being popularised by the Government of India. It is a double-walled insulated metal box, the inside painted black (with boiler paint). A looking glass reflector is hinged to one side of the box and fitted into the lid; a slotted metal bar helps adjust the reflector angle according the Sun's position. Four castor wheels at the bottom help rotate the box. And four cooking vessels, each 20 cm in diameter and 8 cm in height, can be placed in the cooker. The temperature inside the cooker reaches 100° C in winter and 125°C in summer

In the focusing type solar cookers, a concentrator focuses solar radiation and this focused energy heats the cooking pot. The concentrator or reflector may vary—a parabolic, umbrella-type or fresnel reflector or a spherical dish of aluminised plastic, silvered mirror, polished aluminium, etc. However, much heat is lost here because of forced convection by the wind; and where the radiation is diffuse, such cookers are less efficient. Figure 5 shows some typical focusing cookers. The best-known is the Wisconsin cooker developed at the solar energy laboratory at the University of Wisconsin, USA. It uses a 1.2 m-diameter plastic reflector with an aluminised mylar polyster film; it can give an output of up to 400-500 watts at a solar radiation intensity of 1 kilowatt falling on the reflector.

The parabolic cooker, first made in India, has an anodised aluminium reflector, 1.1 m in diameter and with a focal length of 45 cm; it gives an output of about 400 watts. In the umbrella type cooker, the framework is similar to an umbrella frame, but covered with a metallised plastic film laminated to cloth; the diameter is approximately 1.2 m, the focal length 60 cm and the output, again, about 400 watts. Focusing type cookers can also be made in the ground by making a spheroidal depression and then putting an aluminised plastic sheet as reflector. The cooking pot is placed at the focus with the help of a tripod. In the fresnel reflector, in place of a single sheet of reflector, several strips are arranged to focus sunlight at a point. One could also use several small mirrors; this multifaced mirror cooker has been tried in Israel, using 12 concave glass mirrors, held together by circular rings. The cooker gave an output of about 560 watts.

The advanced solar cookers overcome many of the technical prob-

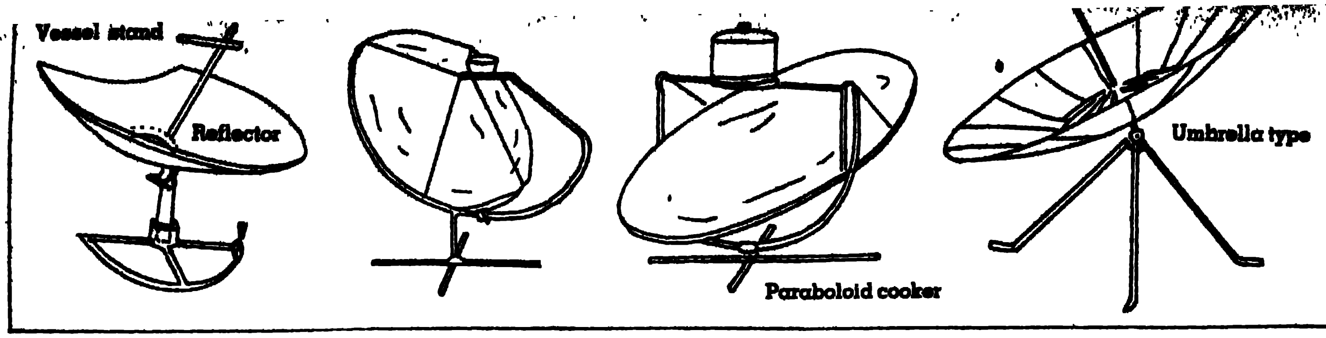
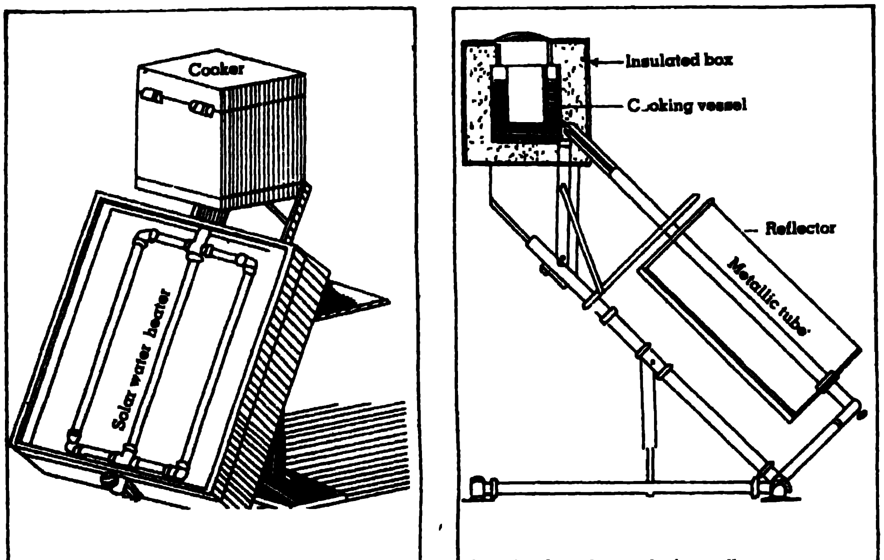


Fig. 5 Some focusing cookers. They need sophisticated manufacturing facilities. They also need to be adjusted frequently towards the Sun. Strong winds affect their efficiency



Solar heater-cum-cooker. Steam produced by the heater cooks the food

A cylindrical parabolic reflector concentrates sunrays on a blackened metallic tube which contains a heat transfer fluid

Fig. 6 Some advanced solar cookers in which food can be cooked away from where solar energy is collected

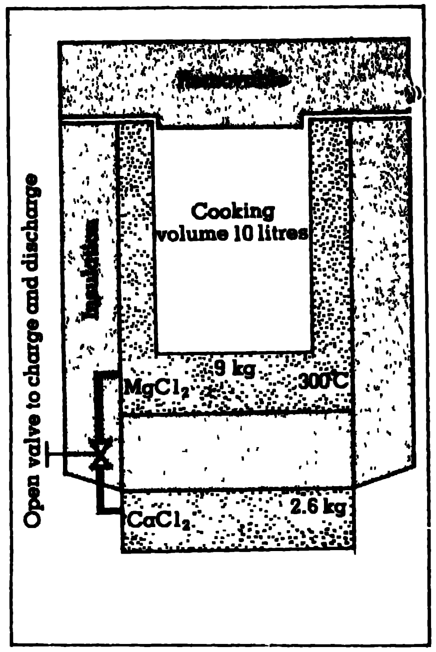


Fig 7. The storage cooking unit

lems and limitations of the cookers discussed so far, though they cost high. In the advanced cooker, solar energy can be transferred away from where it is collected in the open, and even stored for later use. That means one can cook indoors and, with some cookers, even at night. Unlike in the other cookers, here water or any other heat transfer fluid is heated by solar energy in flat-plate collectors (see p. 19) or by linear parabolic concentrators and steam or the hot fluid is carried away and used separately to cook food (Fig. 6).

A new solar energy storage concept, which promises to put solar heat virtually on tap for cooking, has been proposed by C. A. Hall, C. J. Swet and others of the USA. They seek to use ammoniated salts (magnesium chloride and calcium chlorides) to store solar heat. A simple plastic lens concentrates the Sun's heat outside in the open; when the chemical heat storage system (Fig. 7), where the salts are arranged in two separate beds, is exposed to this concentrated heat or charged, it absorbs and stores the heat, releasing it when needed at a temperature of about 300°C. When the unit has been charged, it can be stored at some convenient place by closing a valve until heat is needed when the valve is opened. The unit can be thus charged and discharged several times, and several such units can be used in a family depending on need.

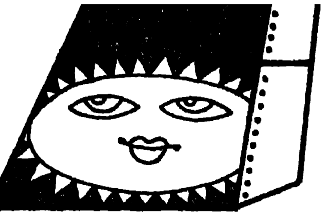
During charging, concentrated heat supplied to the system drives ammonia from the high temperature salt bed of megnesium chloride ($Mg\,Cl_2$) to the low temperature bed of calcium chloride ($CaCl_2$) where it combines with the salt. When heat is required for cooking, the low temperature salt bed is slightly heated, releasing the ammonia which returns to the high temperature bed, reacts with the salt, releasing heat at about 300°C. The cooker, however, is only at a conceptual stage, but appears to be very promising.

The dismal Indian scene

Solar cooker if properly studied and developed can save considerable amount of fuels like firewood, agricultural waste and cowdung in rural areas and coal, gas and electricity in the urban sector. The Department of Non-Conventional Energy Sources, of the Government of India, has been popularising the box type solar cooker with a single reflector. Depending on the dimensions and the materials used, this cooker costs Rs. 450 to Rs. 650. The Government of India offers a subsidy of Rs. 150 on each cooker for personal domestic use. And a few states like Uttar Pradesh, Punjab and Gujarat have also recently started giving a further subsidy of Rs. 150 on each cooker. It means that a buyer pays only

Continued on page 62

SOLAR DRIERS



K.D. Mannan

IN a farm in Ladowal near Ludhiana, the National Industrial Development Corporation uses a large solar drier to dry grains. At Rajahmundry in Andhra Pradesh, tobacco is cured using solar energy, with a supplementary heat source when there isn't enough sunlight.

Crops such as paddy, oilseeds and maize contain 20 to 35 per cent moisture which is not safe for storing. It causes moulds and other microflora to grow on foodgrains, rendering them harmful for use. For storing, the moisture content should be in the range of 10 to 30 per cent.

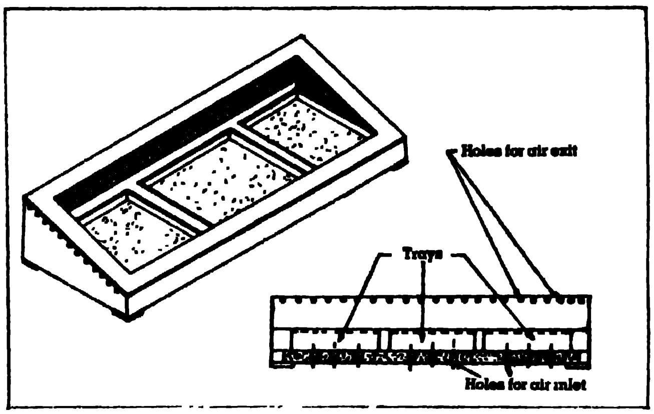


Fig. 1 A typical cabinet drier

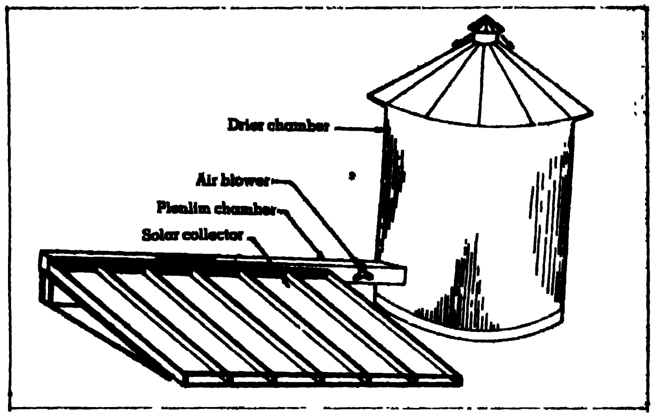


Fig. 2 Forced flow solar drier

Grains, fruits, vegetables, tea leaves, tobacco, coffee, cocoa, fish, timber, etc have, therefore, been traditionally sun-dried. Products are normally spread on ground or hung from chords and exposed to sun. Though it reduces moisture to safe storage levels, there are some drawbacks in this method—contamination by dirt, insects and bacteria and also some loss if the products get wet in rain. And generally the product is not homogeneous, nor of high quality as drying conditions cannot be controlled.

So when a product is required to be dried to certain specifications, it becomes necessary to dry it under controlled conditions. Where drying conditions need not be so stringent, solar energy could be used—as in the case of most agricultural produce. The produce is piled in a bin and sun-heated air is blown upwards from the bottom. Sometimes, the produce is heated directly by solar energy. Drying is faster and the product superior in quality compared to open sun-drying.

How is this done? To go a bit into the basics, drying is a heat and mass transfer process, where liquid water from the surface and from inside the grains is vaporised, mixed with the drying air and the vapour-air mixture removed. The drying air provides the heat and gets progressively cooler as it passes through the produce. Several factors affect this drying process (see box on p. 78), the most important being the relative humidity of the drying air. The drying air temperature is also important; it must be below a certain maximum depending on the crop and its intended use. For produce to be used as seed, the temperature should be lower (between 45°C and 60°C, depending on the crop and the initial moisture content of the crop) than when the crop is to be used as food or feed.

There are two types of driers: natural convection driers and forced flow driers. In the natural convection or cabinet drier, the produce receives solar energy directly and air is circulated by natural convection. It is a glass/plastic-covered box, usually with one or two transparent covers, a blackened interior surface and an insulated bottom (Fig. 1). Holes are drilled

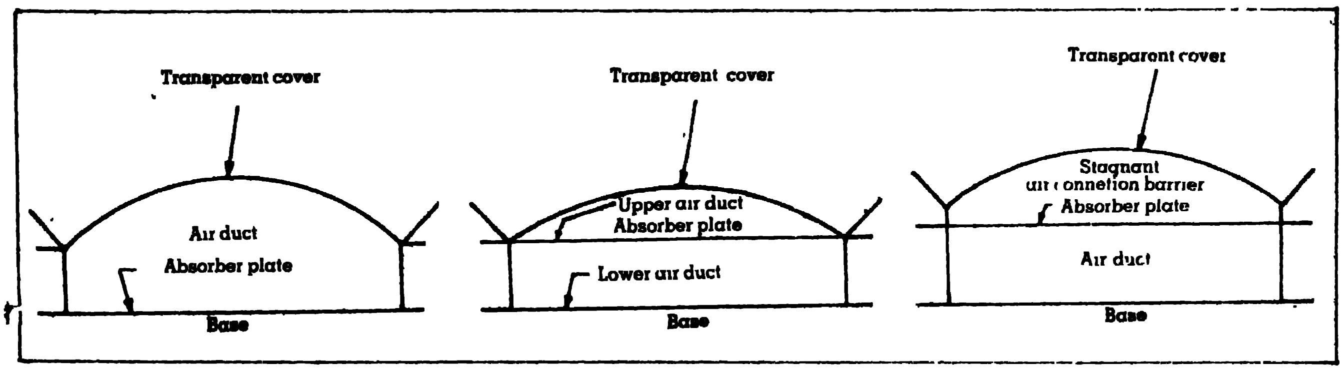


Fig. 3 Basic types of solar air heaters

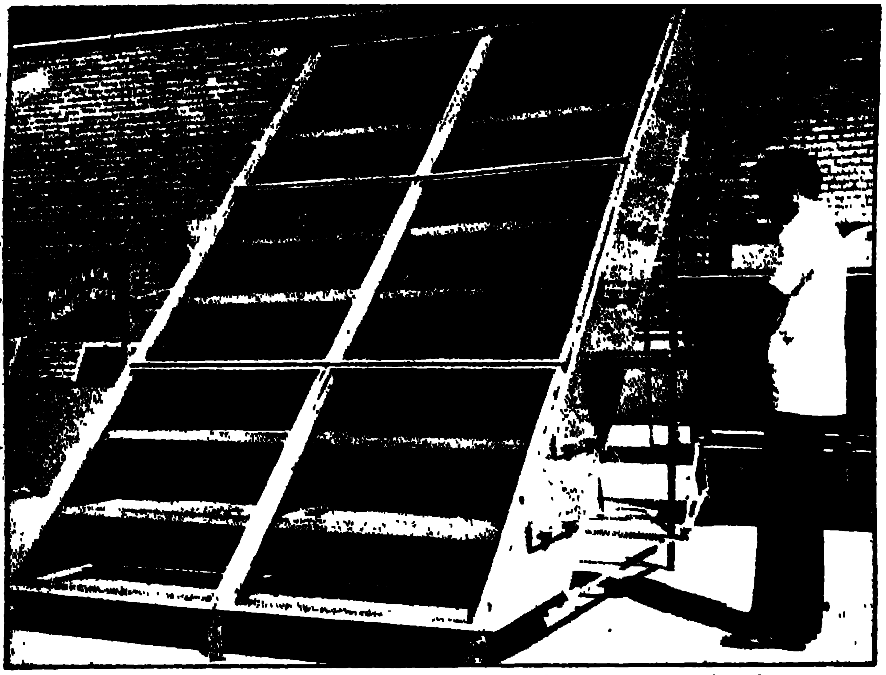


Fig.4 Multi-rack natural convection drier developed at the Punjab Agricultural University, Ludhiana

through the base and upper sections of the side and rear walls to induce air flow. The produce to be dried is placed on perforated drying trays.

As solar energy passing through the transparent cover is absorbed by the produce and the interior of the drier, the air temperature in the drier rises and the heated air moves up and leaves the drier through the holes in the sides. Fresh air enters the drier through the holes in the bottom, gets heated, removes moisture from the produce and again goes out of the drier. This process continues till the interior of the drier is hotter than the surroundings. The air temperature in the drier rises sufficiently high, from 20°C to 40°C above ambient, depending on the solar intensity.

Since the air flow rate caused by natural convection is rather low, drying takes long and such a system is not suitable for largescale drying But the advantage is that it does not need any other source of energy (electrical or mechanical). Simple in design, these driers can be fabricated easily by village artisans.

In a forced flow drier, air heated in a solar air heater is forced into the drying chamber with the help of a blower. It has been used to dry cereals, oilseeds, cowpeas, timber, etc.

A typical forced flow solar drier (Fig. 2) has an array of flat-plate collectors (commonly known as solar air heaters) for heating air, a drying chamber or bin with a perforated floor, a blower with

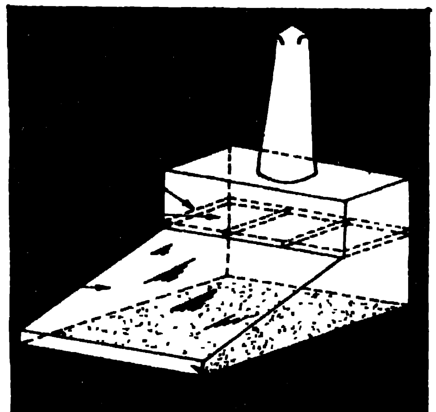


Fig.5 IIT design of natural convection solar drier

an electric motor/engine and a duct system connecting the collectors, the blower and the drying chamber. The flat-plate collector consists of an insulated solar energy absorber and an arrangement to blow air across or along the absorber. The collector surface receiving solar energy is generally covered with one or more transparent covers (glass or plastics) and is insulated on all other sides. The collectors are placed fa ing south in the northern hemisphere and is appropriately tilted.

Several designs have been worked out and they differ on the basis of: (i) the shape and type of materials used as solar energy absorbers, for example, corrugated sheets, mild steel flat sheet, blackened glass strips, iron stones and pebbles; (ii) the number of transparent covers used; and (iii) the type of air flow configurations (the three basic types are shown in Fig. 3). The performance of the solar air heater depends on the intensity of solar radiation, the orientation of the collector, air flow rates, the number of transparent covers, the type of absorber and the temperature level at which heat is being collected.

In many forced flow solar driers, the roof of the grain storage building itself has been used to collect solar energy. In one such system, blackened corrugated sheet metal was used for the roof under which a plywood air duct was provided to draw air by means of a circulating fan; the heated air was forced through the perforated floor. A plastic or glass cover over the roof improved solar energy collection whenever a temperature rise of 8°C or above was desired.

Drying vegetables and fruits has been tried out in several places in India—the Indian Institute of Technology, Kanpur, Annamalai University, Tamil Nadu, Central Arid Zone Research Institute, Jodhpur, IIT, Kharagpur, Punjab Agricultural University (PAU), Ludhiana, Tamil Nadu Agricultural University, Coimbatore, Rice Research Institute, Cuttack among them. Most of them have used simple cabinet driers which have a drying capacity of 1.5 kg per square metre per day on sunny days.

Some innovative work on the design of direct driers has been reported from PAU, Ludhiana, where a multi-rack natural convection drier (Fig. 4) has been developed and extensively tested. Instead of keeping the produce to be dried at one level, here it is spread on many levels so that the drying air after passing through the produce at one level gets heated and passes through a second layer, drying it, and then getting heated again, passes through yet another layer. Nearly 6 kg of vegetable/fruits can be dried per square metre in two days.

Studies have also been carried out at the IIT, Delhi, on another design (Fig. 5), where the air gets heated at one end

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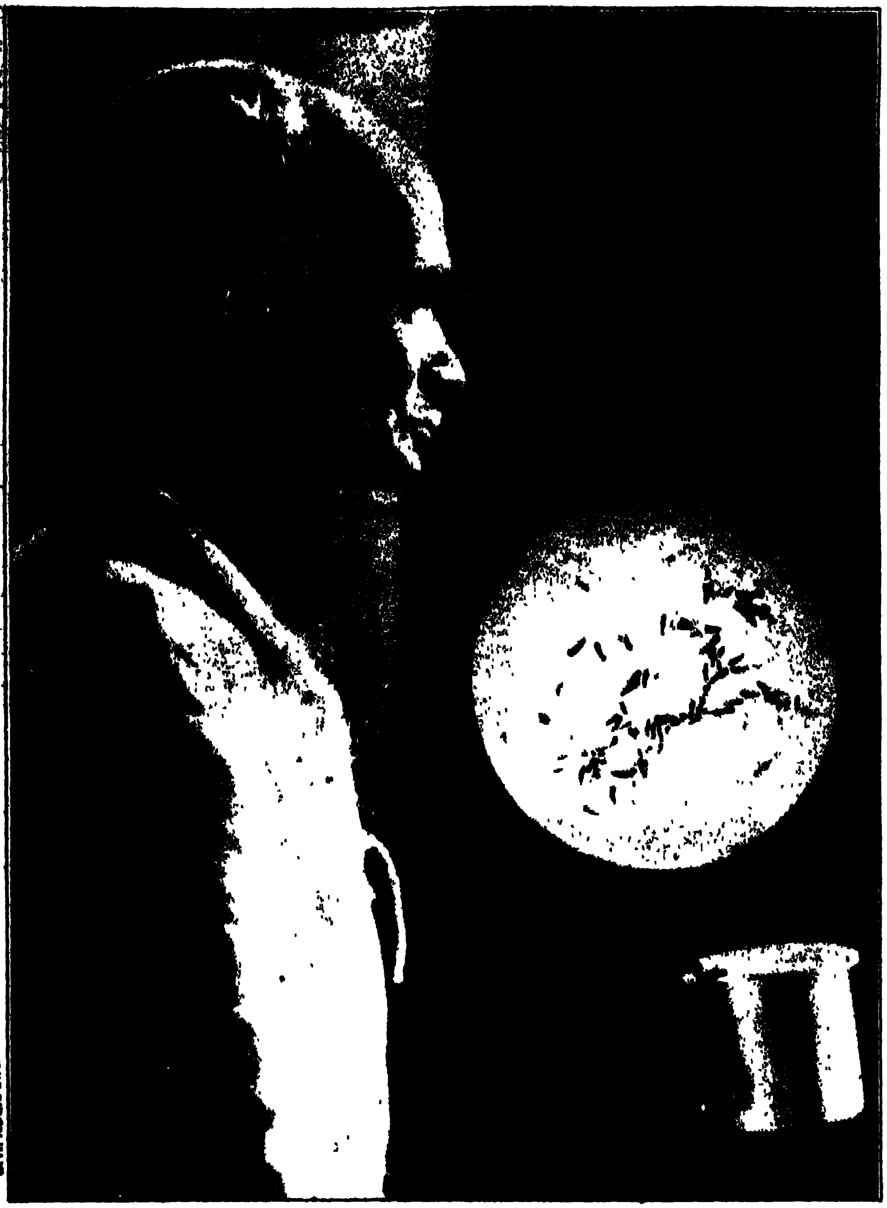
TUBERCULOSIS: THE KILLER TAMED



S. N. KULKARNI

Sputum cup with a closed lid. Inset: Koch's bacillus highly magnified

GOOD evening, Doctor.

Good evening. What can I do for you?

Doctor, I have fever, a cough and chest pain. My appetite has suffered and I have lost weight. I have also noticed blood in my saliva. Aren't these symptoms of tuberculosis?

Now relax. I can only answer your questions after I have examined you. But don't worry. Modern treatment can cure tuberculosis in a vast majority of patients and TB is no more a killer. Besides, the symptoms you describe are also seen in other lung diseases

But no one in my family has ever had tuberculosis...

Let me explain. Tuberculosis is not a hereditary disease. It is a bacterial infection caused by Koch's bacillus (after Sir Robert Koch who discovered the microbe), *Mycobacterium tuberculosis*. TB can be 'caught' by inhaling these bacilli, which are expelled in the sputum of people who are 'open' cases of pulmonary tuberculosis.

Once the tubercle bacilli enter the lungs, they spread and cause inflammation of the lungs. The lung tissue is literally eaten up and a 'cavity' or hole forms. Inside the 'cavity', bacilli multiply rapidly and the person develops what is called an 'open' case of tuberculosis. When an 'open' case of TB coughs, he throws out a blast of bacilli, infecting others who come in contact with him.

Can tuberculosis spread to other parts of the body?

Tuberculosis can affect any tissue of the body, except the nails and hair, but the lungs are the most commonly infected. TB of the lungs is called pulmonary tuberculosis; other types of tuberculosis are comparatively rare.

Doctor is it true that tuberculosis 'caught' in childhood can later develop into an infection in adulthood?

Yes. In India we have a large number of tuberculosis patients. This is a 'pool' of infection. At any time we have about five million active cases in the country. Because of this, any one can catch the infection in early childhood. The bacilli enter the child's lungs by inhalation and cause a patch of pneumonia called a 'primary focus'. The glands draining the area also get infected, causing a 'primary complex'.

If a child has pneumonia, does it also imply TB?

Pneumonia is an infection of the lungs caused by bacteria, viruses or other diseases like cancer. But infection by tuberculosis bacteria do not always result in the disease. If the child has good resistance, that is, the capacity to fight infection, then he recovers temporarily. But the tubercle bacilli get locked in the body and attack the person later on in adulthood when his resistance is low.

Doctor, what precautions should be taken to protect children from the disease?

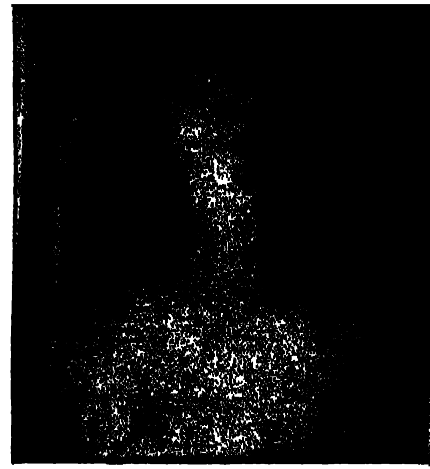
Because of the heavy 'pool' of infection, it is difficult to avoid it. So early diagnosis, effective treatment, and building up the child's resistance, are the best course of action.

How do you diagnose TB?

Diagnosis involves analysing the symptoms first. In children, there may be prolonged fever, a hacking cough, loss of appetite, failure to gain weight and repeated respiratory infections and diarrhoea. In adults, fever, cough, chest pain, blood in the sputum and loss of weight are the give away.

Doctor, last year my doctor did a TB skin test for my baby. What exactly is it?

It is the tuberculin test. We inject a suspension of tubercle bacilli into the skin of the forearm, and watch the reaction after 48 hours. If the person is infected with TB,



Normal chest X-ray (left), X-ray of a tuberculosis patient, showing infiltration of tubercle bacilli causing cavities and opacities (Right)

the site of infection swells like the sting of a bee. We measure the diameter of this raised portion or "induration", and if it is more than 10 mms. the test is positive.

Doctor, does a positive test indicate TB?

No. It only means that the person is infected. To check for the disease, we take a chest X-ray in children and a sputum examination and X-ray in adults.

But doctor, my other child was given the BCG vaccination at birth and her test was ***positive. What does this mean?***

The BCG is an artificial infection with tubercle bacilli whose disease causing power is reduced and whose immunising power is increased. After a BCG, the tuberculin test can be positive with the swelling extending upto 12 mms.

Doctor, what blood tests are done?

We test blood for anaemia, infections associated with other organisms and in elderly persons for diabetes. E.S.R (erythrocyte sedimentation rate or the rate at which red blood cells settle down under fixed conditions) was done in the past but not any more, as this test is not specific.

Doctor, what is the typical picture in chest X-rays?

In children one finds enlarged glands by the side of trachea (wind pipe) or near the hilum (an opening in the lung tissue, through which blood vessels or air passages pass). In adults, TB mainly affects the upper parts of the lungs. Nodular opacities or infiltration develop initially. Later on, cavities along with linear shadows called fibrosis occur. As the disease progresses, destruction and/or shrinkage occurs.

Doctor, if the sputum does not show any bacilli, does it mean that the person does not have TB?

No. A positive sputum test confirms the diagnosis and also shows that the person is infectious to others, but a negative sputum test does not mean. tuberculosis is absent. If the sputum test is negative by a stained smear examination, then we culture the sputum smear on a special medium to see if organisms grow. Finally we inject a guinea-pig with sputum and then kill it to find out if it develops TB

Doctor, how do you treat TB?

Before we start treatment, we have to make sure whether the disease is active or healed. TB, though healed, may show calcified spots on the chest X-ray. This needs no treatment. Once active TB is confirmed, treatment consists of proper, prolonged, uninterrupted treatment with anti-TB drugs, a well balanced diet, with adequate proteins, vitamins and minerals, the correction of anaemia, control of diabetes and ultimately surgery, depending on the seriousness of the case.

Does a change of climate help a TB patient?

A change of climate was advised in the past when anti-TB drugs were not yet discovered, but now *hawa* has been replaced by *dawa*.

Doctor, what are the drugs used?

There are 10 different drugs having anti-TB action. They are streptomycin, isinicotinic acid hydrazide, para-amino salycilic acid, thiacetazone, ethambutol, pyrazinamide, morphizinamide, ethionamide, kanamycin, and the most powerful, rifampicin.

Doctor, I hear a number of drugs are used at the same time, are they necessary?

Yes, TB germs have a tendency to develop resistance to the drugs if used alone, hence we prescribe a combination of drugs. There are two types of drugs. Those which kill the tubercle bacilli which are known as bactericidal drugs and those which just stop the further growth and immobilise them. These are called bacteriostatic drugs. Rifampicin, INAH, pyrazinamide and ethambutol are "cidal" while others are "static"

Doctor, if the drugs have to be taken for a long time do they have any side-effects?

Yes, there are minimal side effects but most of them disappear when patients stop taking the drug. Strepto has a toxic effect on the hearing and the kidneys Rifampicin, INAH, ethionamide and pyrazinamide affect the liver. Ethambutol has an effect on the vision. But these side effects are uncommon.

How long does the treatment last?

TB is a chronic and relapsing disease, so all bacilli must be destroyed leaving no residual bacteria Treatment is continued for 18 to 24 months or even longer. But many patients discontinue the treatment in between. These patients run the risk of harbouring resistant strains of the organism and when they infect other people the drugs are ineffective even for them.

Can't you cut-short the treatment?

Yes, now one can. Rifampicin treatment can reduce the time span to 9-12 months. This is called short term chemotherapy.

Doctor, is the treatment costly?

Well, once you catch a disease, you have to treat it properly and cost becomes a secondary consideration. Moreover TB drugs are supplied free by government institutions, municipal clinics and hospitals, the TB Association clinics and many other voluntary organisations. No one should cite cost as an excuse for not completing the treatment. It is very important to take the treatment without interruption, for the prescribed period and not to forget proper check ups, a balanced high protein diet and plenty of rest.

What about surgery?

After the drug treatment is completed, the residual disease should be removed by an operation on the lungs, to prevent future relapses.

What about life after TB?

We cure TB but after effects tend to diminish the capacity of the lungs to function normally. The main function of the lungs is oxygenation and oxygen is required every second. So after complete treatment, one should guard against respiratory infections, avoid smoking, alcohol intake and do regular breathing exercises.

Doctor, can a person marry after recovering from TB?

Certainly. But in a woman, pregnancy should be delayed for at least one year after the cure is complete. If she gets pregnant, she should be under close observation.

What happens if a pregnant woman gets TB!

That depends on the stage of TB and the period of pregnancy If TB can be controlled, the pregnancy may be allowed to continue, but if it is advanced, an abortion is advised.

Doctor, can a tuberculous mother breast-feed her baby?

The mother's sputum must be negative, to ensure that the infection does not pass through the milk. But even then, the close contact during breast-feeding can carry the infection to the baby. With proper precautions, however, breast-feeding is allowed.

Continued on page 39

EXCITING CALCULATOR KEYBOARD

WORKING with a calculator can be exciting when you discover that the numbers on the keyboard follow certain properties. The keyboard configuration is as follows:

7	8	9
4	5	6
1	2	3

From the keyboard, we have, 123 + 654 + 789 + 987 + 456 + 321 = 147 + 852 + 369 + 963 + 258 + 741 = 3330

Let us call this an S×S property (the method of addition follows an S). The second property of the above configuration is 147 + 753 + 369 + 963 + 357 + 741 = 789 + 951 + 123 + 321 + 159 + 987 = 3330

We can call this a Z×Z property (the method of addition follows a Z). The property is not restricted to these numbers above. It is also true for any 3×3 configuration of single, double... upto n digit numbers, that is,

n+6	n+7	n+8
n+3	n+4	n+5
n	n+1	n+2

For example, let us take the following 2 digit numbers:

72	73	74
69	70	71
66	67	68

We see that 666768 + 717069 + 727374 + 747372 + 697071 + 686766 = 666972 + 737067 + 687174 + 747168 + 677073 + 726966 = 4242420 (S×S property). Also 666972 + 727068 + 687174 + 747168 + 687072 + 726966 = 727374 + 747066 + 666768 + 686766 + 667074 + 747372 = 4242420

Take an example of 3-digit numbers:

112	113	114
109	110	111
106	107	108

The sums are equal to 660660660.

The sums obtained, as we can see, are very well patterned. In fact, the pattern unit is of length 1 digit for the 1-digit sum (3330), of length 2-digit (42 42 420) for a 2-digit sum and of length 3-digit (660 660 660) for a 3-digit sum. The pattern unit is 4-digit long for a 4-digit sum. Take for example:

1271	1272	1273
1268	1269	1270
1265	1266	1267

The sum comes to 7614 7614 7614

So the question is whether it is n-digit long for a n-digit sum. An answer to this or a counter example for this interesting property from any of the readers is welcome.

R. Satyanarayan

Mr. Satyanarayan is a student in Bombay. Calculus and Number Theory are his favourite subjects.

A versatile magic square

THE magic square formed by 1089 and its multiples (Fig. 1) is a versatile one. Its magic constant is 16,335. What is versatile about this square is that it retains the magic instant when some digits are deleted from all the nine four-digit numbers occupying its cells. For example, if the first three digits be deleted from all the numbers then the resulting square is magic having a constant of 15. By deleting the last three digits, similarly, a magic square of constant 15 is obtained. By deleting all except the second or the third digits, magic squares of constant 12 are produced.

When the last two digits are deleted from all the four-digit numbers, a magic square having a constant of 162 is obtained. Similarly, by deleting the first two digits there results a magic square of constant 135. Deleting the middle two digits from all the numbers generates a magic square of constant 165. Deletion of the extreme digits from all the numbers likewise leads to a magic square of constant 132. With three digits four different magic squares are possible. These squares have magic constants of 1632,1635 1635 and 1335 respectively (Fig. 2-5).

P. K. Mukherjee

Dr Mukherjee is a lecturer in Physics at Deshbandhu College, New Delhi

8712	1089	6534
3267	5445	7623
4356	9801	2178

Fig. 1

871	108	653
326	544	762
435	980	217

Fig.2

872	109	654
327	545	763
436	981	218

Fig.3

812	189	634
367	545	723
456	901	278

Fig.4

712	089	534
267	445	623
356	801	178

Fig.5

Number mosaic

NUMBERS and patterns often keep interchanging roles, each supporting the other in turn. In the mosaic designs which they have together created alongside is an elegant example of this type of interaction.

Example:

$$\frac{0^5+1^5}{0+1}+\frac{1^5+2^5}{1+2}+\frac{2^5+3^5}{2+3}+\frac{3^5+4^5}{3+4}$$
$$=4^3+4(3^3)+8(2^3)+12(1^3)$$
$$=248$$

1^3 $=\frac{0^5+1^5}{0+1}=1$

1^3
$+$
$1^3+2^3+1^3$
$+$
1^3

$=\frac{0^5+1^5}{0+1}+\frac{1^5+2^5}{1+2}$
$=1+11=12$

1^3
$+$
$1^3+2^3+1^3$
$+\ +\ +$
$1^3+2^3+3^3+2^3+1^3$
$+\ +\ +$
$1^3+2^3+1^3$
$+$
1^3

$=\frac{0^5+1^5}{0+1}+\frac{1^5+2^5}{1+2}+\frac{2^5+3^5}{2+3}$
$=1+11+55=67$

1^3
$+$
$1^3+2^3+1^3$
$+\ +\ +$
$1^3+2^3+3^3+2^3+1^3$
$+\ +\ +\ +\ +$
$1^3+2^3+3^3+4^3+3^3+2^3+1^3$
$+\ +\ +\ +\ +$
$1^3+2^3+3^3+2^3+1^3$
$+\ +\ +$
$1^3+2^3+1^3$
$+$
1^3

$=\frac{0^5+1^5}{0+1}+\frac{1^5+2^5}{1+2}+\frac{2^5+3^5}{2+3}+\frac{3^5+4^5}{3+4}$
$=1+11+55+181=248$

A. K. Kanga

GROWTH FACTOR RECEPTOR IN A NEW DOMAIN?

GROWTH is the fundamental feature of life. Every individual starts life as a single cell which undergoes numerous cell divisions to form a multicellular organism. The understanding of the complexities of normal growth is a challenge to all cell biologists. For a long time now it has been known that hormones regulate growth of specific tissues. To these have been added other growth promoting substances, known as growth factors. One of the first growth factors to be identified was Nerve Growth Factor (NGF) by Rita Levi-Montalcini in 1951. The NGF stimulates sympathetic ganglia and nerve cells to divide in chick embryos and in new born mice, but not in adult animals.

Thus, there must be other factors which are involved in controlling normal development. Growth factors may also be required for regulating proliferation of cell types with a rapid turnover, as well as in wound healing and regenerating tissues. During the last decade, a host of growth factors have been isolated and characterised. And, we know now that they are low molecular weight polypeptides and act on the cells through specific receptors which are situated on the cell surface.

During studies with NGF in 1962 Stanley Cohen, working with R. Levi-Montalcini, accidentally discovered another growth factor called Epidermal Growth Factor (EGF). Crude extract of mouse salivary gland, which is a rich source of NGF was injected into new-born mice to study the effect of NGF on the nervous system. To the surprise of the investigators, in addition to the growth of sympathetic nerve cells and ganglia, the treated mice opened their eyes earlier than the control mice. Precocious eruption of teeth was also observed. Histological studies indicated these two effects to be due to an overall thickening of the epidermis. This led to the discovery of EGF, which is present along with NGF in large quantities in mouse salivary glands.

EGF receptors on human cells labeled by fluorescent antibodies and visible as bright regions

EGF is a potent mitogen for cells of epidermal as well as mesodermal origin. Like other growth factors, it acts through specific receptors situated on the cell membrane. EGF binds to its cellular receptor and within minutes the EGF-receptor complex is removed from the cell surface by a process of internalisation. This sets into motion a chain of reactions which finally result in DNA synthesis and cell division. It is not yet clear whether the growth factor itself carries the information for the cell to divide or whether the signal resides in the receptor.

The EGF receptor has now been purified and well characterised. It is a high molecular weight glycoprotein situated in the membrane and associated with protein kinase activity which has a specificity for phosphorylating tyrosine. Similar findings have been reported for receptors of other growth factors and several viral transforming proteins. It has been suggested by some authors that protein kinase could stimulate growth by usurping a cellular growth control pathway which uses tyrosine phosphorylation.

A recent paper in *Nature* (309 270) by Mroczkowski, Mosig and Cohen, suggest that the EGF receptor is associated with an endonuclease which acts directly on DNA and brings about a change in its structure. The highly purified EGF receptor preparation can actively nick double-stranded circular DNA in the presence of ATP. This activity is similar to that of an enzyme, DNA topoisomerase II which catalyses topological rearrangements of DNA—an important step in regulation of transcription and replication. The authors, however, do not rule out the possibility of the highly purified EGF receptor preparation being contaminated with trace amounts of the endonuclease.

The products of oncogenes (genes activated in cancerous cells and not in normal cells) seem to share some properties with the EGF receptor. The product of the transforming gene of Rous Sarcoma Virus, $pp60^{src}$, has the kinase activity and now it has been shown to have the endonuclease activity as well. Are oncogene products then related to the growth factor receptor? Do they also act directly on the DNA and stimulate cells to divide? A clue to how cells are stimulated to divide may help in arresting cancer which is nothing but uncontrolled growth of cells.

R. Mulherkar

Dr. Mulherkar is with the Cell and Developmental Pathology Department of the Cancer Research Institute, Parel, Bombay.

Virus foot-prints in human breast cancer

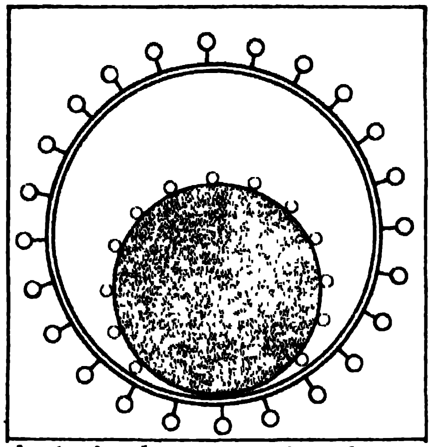
IN INDIA cancer of the breast is one of the most common cancers in women, preceded only by the cancer of uterine cervix. Cancer, as such, is yet an enigma, and hence it is appropriate that recent trends in cancer research focus on its causes (etiology). In the past decade and a half, the role of virus in the etiology of breast cancer has been studied intensively. This is partly due to the advances in the understanding of the mode of replication of the viruses, and the molecular events leading to their involvement in neoplastic transformation. The most promising line of research in this respect has been the use of elegant animal tumour models, particularly of mammary tumours. In certain strains of mice, breast cancers can be transmitted from mothers to daughters. Analysis of the milk of these strains of mice, showed the presence of virus particles, referred to as Bittner virus or Mouse Mammary Tumour Virus (MMTV).

MMTV is a retrovirus. A retrovirus is a RNA tumour virus, in contrast to the DNA tumour viruses. It has a characteristic architecture with an eccentric nucleus and prominent spikes on its membrane, called a typical 'B' type particle. The MMTV has a high molecular weight 70S RNA genome, and replicates through a DNA intermediate. The DNA copy of the RNA tumour virus is called the proviral DNA The provirus is formed from this RNA tumour virus by the reverse transcriptase enzyme, which is an integral part of the MMTV. Interestingly, MMTV is known to be present ubiquitously in normal tissues. It is either an endogenous virus transmitted vertically through the gametes

of the species, or an exogenous virus transmitted via milk.

Although, MMTV is one of the principal causative agents in the development of mouse mammary tumours, the incidence and progression of the disease is multifactorial. Other parameters influencing the tendency to form mammary tumours include the genetic background and hormonal status of animals. The mammary tumours are initially, often hormone-dependent, developing during pregnancies, and regressing partially or completely between pregnancies. Eventually, the tumour becomes autonomous, growing independent of the hormonal status of the animal. However, the number of pregnancies required to establish hormone independence is often variable.

Recently, G. Peters, A. E. Lee and C. Dickson (*Nature* **309** 273) have shown that in some recurring pregnancy-dependent mammary tumours, additional provirus integration within a certain region in host DNA occurs at the earliest appearance of the tumour. This region has now been identified on mouse chromosome 7, and termed



A retrovirus has an eccentric nucleus and prominent spikes on its surface membrane

as *int-2*. The proviral integration may activate specific cellular genes, including a putative oncogene. Cellular oncogenes are genes which may serve to initiate the genesis of tumours and sustain the final neoplastic phenotype. They are not tumourigenic in their native state. However, integration of retroviral DNA into host chromosome may activate them to initiate tumourigenesis. Hence, the additional MMTV proviral integration may then represent an important step in the development of neoplasia.

The ultimate goal of experimental oncologists is to extrapolate the data gathered from the laboratory to the human situation. In this connection, MMTV studies in mouse tumour models are of immense value. There have been reports showing presence of mammary tumour virus-like particles in electron micrographs, from human milk. These findings are further substantiated by the presence of the 70S RNA, reverse transcriptase enzyme and immunological cross reactivities with the mouse MMTV. Thus, there is evidence of specific footprints of the virus in human breast cancer. Further studies using mouse mammary tumour models may provide useful leads to unravel the complexities of human breast cancer.

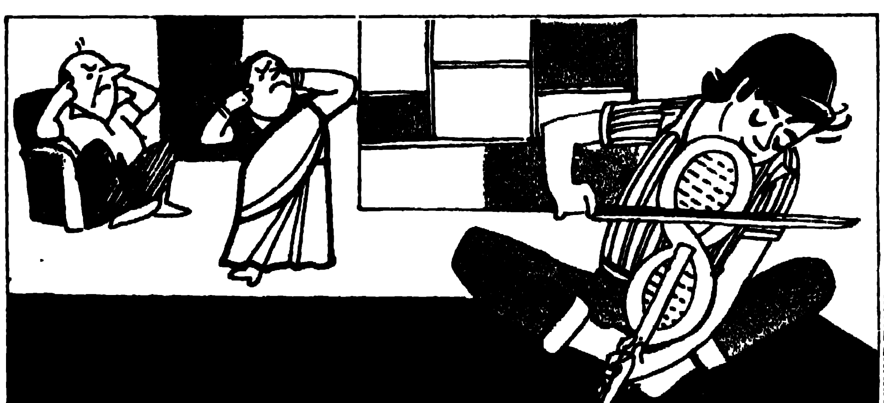
Dhananjaya Saranath

Dr. (Mrs) Saranath is with the Immunology Division of the Cancer Research Institute, Parel, Bombay.

Musical genes

WHAT has genetic engineering and music got in common? Well, you could trust the Japanese to come up with an original correlation between the two. Two Japanese scientists Kenshi Hayashi and Nobuno Munakata of the Biochemistry Division and Radiobiology Division, National Cancer Centre Research Institute, Tokyo, Japan, in a letter to a recent edition of *Nature* (**310 96**) have proposed an acoustic method for handling nucleotide sequences.

The justification for such a method is sought in the enormous amount of base sequence data that is constantly accumulating with rapid advances in gene cloning and DNA sequening techniques. In several cases, the initial data, read from autoradiograms of sequencing gels, are either handwritten or typed out to be later transferred to a computer through keyboards. Dealing with hundreds and thousands of meaningless A, T, G and C sequences, standing for the four nucleotides adenine, thymine, guanine and cytosine is tedious and boring. Chances of making mistakes while transcribing from handwritten/typed pages to computers are also high and needs constant checking and rechecking. No wonder the Japanese's musical scale is already arousing considerable interest in those working on nuclear sequences.



MUKUND TALWALKAR

Let's try to understand the acoustic method. The Japanese "chose a tone range of a fifth since this occurs in daily speech. Avoiding a half-tone, three possible arrangements can be considered; bottom-heavy (do, re, mi, sol), symmetrical (re, mi, sol, la) and top heavy (mi, sol, la, si)." They picked up the second one as the symmetry can be explored in future use Then the pitch-to-base assignment is "re" for G, "mi" for C, "sol" for T and "la" for A.

Using this system, the Japanese found that "G + C-rich sequences are low-keyed, while thermally less stable A + T-rich sequences are high-keyed Purine clusters, which tend to distort DNA structure, are leaping and unsettled, while pyrimidine clusters are even and placid. Sequence-melodies can then be transcribed in a two-line score, which is an abridged version of the five-lined score (taking out the upper three lines."

The advantages of this method are obvious--sequences can be easily recognised and memorised and a computer equipped with a sound-generating system can even sing back the sequences to enable confirmation by ear Last, but not the least, will it not be fun decoding the mysteries of life from singing computer? □

THE BEGINNING OF 'THE END OF' CANCER

Sushilkumar G. Devare

WHAT causes cancer? The question continues to perplex scientists. What is surprising is that it is only a single cell which defies the whole body mechanism. This cell, for some reasons still not known, refuses to obey the laws of normal cell division and arrogantly continues multiplying. The result being cancer—a dreadful disease.

What triggers the cell to behave abnormally? What causes the normal cell division to go haywire? Answers to these and other related questions are not yet clear, though recently, scientists have made important breakthroughs leading to a better understanding of these questions. One such approach which is being considered by the scientists is that, in the presence of oncogenes (cancer genes), cells manufacture abnormal protein(s) which cause the malignant cell growth. It is intriguing that one such protein having a similar structure as the platelet derived growth factor (PDGF, released by platelets present in blood during the wound healing process), has been identified to cause malignancy.

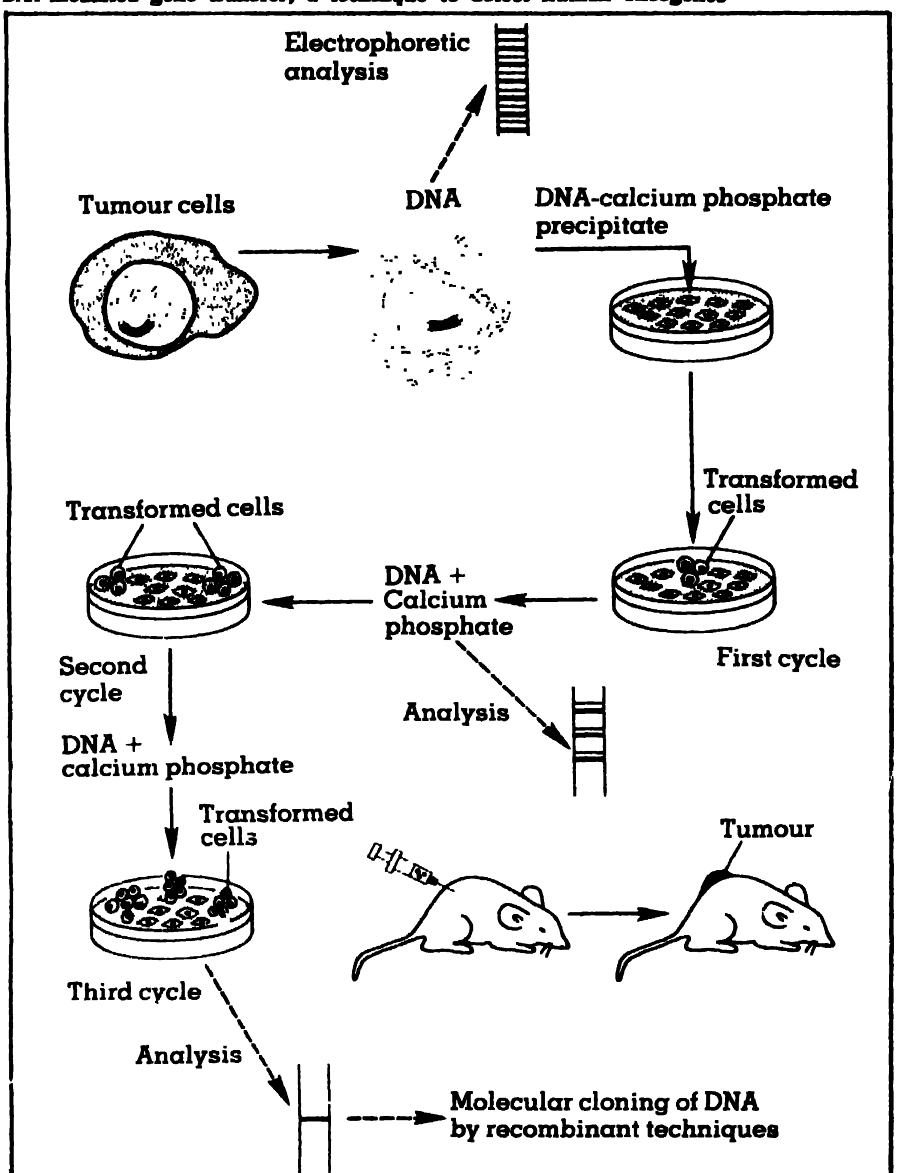
Before going into the details of PDGF, let us start from the beginning. The year was 1910, when Peyton Rous at Rockefeller University, New York, first demonstrated that a virus was causative for tumours in chicken Discovery of "Rous Sarcoma" virus and its role in tumour induction was largely responsible for his Nobel Prize in 1966.

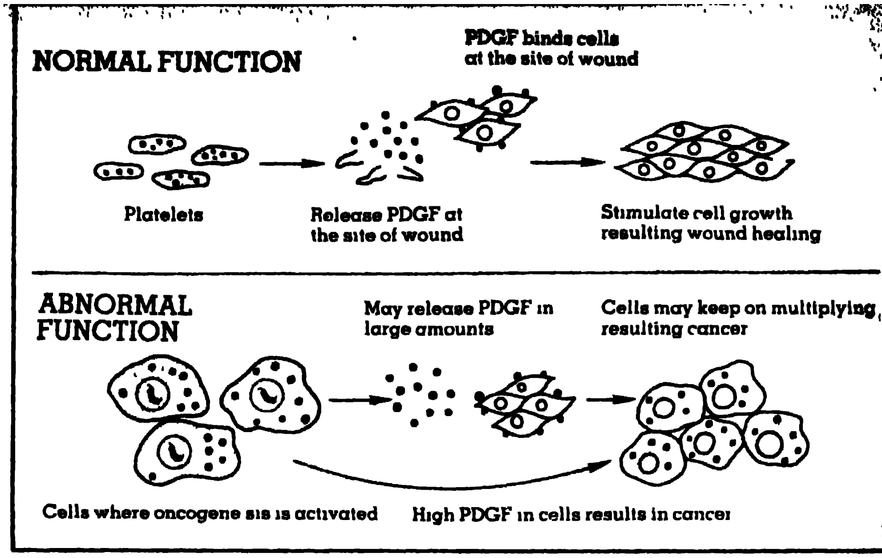
We have come a long way since the discovery of Rous sarcoma virus. More than seven decades later, researchers have finally begun to understand the molecular basis of tumourogenesis—how tumour virus converts normal cells into malignant cells. The emergence of recombinant DNA technology (SCIENCE TODAY, December 1983) made it possible to isolate a particular gene while the rapid DNA sequencing techniques assisted in determining the molecular structure of genes: an achievement which would have remained fictional.

The existence of cancer genes oncogenes ('onco' for tumour) was hypothesised more than a decade ago. The "Oncogene hypothesis" was based on research on animal tumour viruses known as retroviruses (SCIENCE TODAY, April 1983, p. 27). Retroviral genetic information for most of the known viruses is present in the cell and can be induced to express under specific conditions. These retroviruses are present in cellular DNA and are silent most of the time. Several retroviruses have been isolated from various animals such as chicken, mouse, rat, cows, monkeys and more recently from human. During the past four years, the genomes of the known important retroviruses have been molecularly cloned using recombinant DNA technology. Further, the genetic information present in these genomes have been deciphered using DNA sequence analysis.

It has been postulated that oncogenes may be expressed during

DNA mediated gene transfer, a technique to detect human oncogenes





Normal and abnormal functions of PDGF showing transformation by simian sarcoma virus or activation of an oncogene related to PDGF

normal cellular differentiation process and may be regulated or switched off subsequently. Several oncogenes from distinct species now show DNA sequence homology and appear to contain some or closely related oncogenes. Also, viral oncogenes have been demonstrated to be evolutionarily conserved. For example, if one tries to search for a gene similar to an oncogene present in a rat virus in human cellular DNA, using molecular biology techniques, it is possible to identify equivalent human oncogene.

Oncogenes and tumours

Oncogenes present in the normal cells are capable of inducing tumours. However, under normal circumstances, expression of cellular oncogene is regulated or controlled. Researchers have performed experiments in which an oncogene isolated from normal cells is linked to control elements which regulate its expression.

Several experiments have now suggested that quantitative over-expression of an oncogene turns the normal cell malignant. In fact, specific chromosomal abnormalities are associated with certain kinds of cancer. This includes gene rearrangement leading to activation of cancer gene as suggested by George Klein of Karolinska Institute, Sweden.

In search for more cancer genes in human tumours, scientists have made use of DNA-mediated gene transfer technology. The genes responsible for the transformation of normal to malignant cells have been molecularly cloned and structures have been determined.

Scientists believe that there is much complexity in the mechanism of human cancer and that our present day knowledge is a small portion of the whole picture. However, using retroviral oncogenes or using DNA-mediated gene transfer, we have come closer towards understanding the mechanism of tumourogenesis either of viral or non-viral origin.

Presently, we have access to around 20 oncogenes from acute transforming retroviruses isolated from various animals. We also have the cellular homologues for each of the viral oncogenes which could be identified and molecularly cloned using the latest techniques of recombinant DNA methodology. However, the progress in determining the function of the proteins encoded by the oncogenes has been disappointingly slow. Of more than 20 independent isolates of acute transforming retroviruses, certain isolates appear to contain same or closely related oncogene. The oncogene of several members of these acute transforming retroviruses including Rous sarcoma virus, encode for a protein which has enzyme activity of protein kinase with rather unique specificity for phosphorylating tyrosine residues. The members of another class of acute transforming retroviruses have oncogene products which bind specifically to guanosine nucleotide. However, regarding the physiologic functions of the oncogene encoded proteins, until recently, we did not have a single clue to understand how these proteins convert normal cells into cancerous.

> The pioneer research work by Dr. Devare has led to the identification of an oncogene protein related to PDGF, responsible for abnormal growth

The major breakthrough in the area of cancer research came from the work on the oncogene present in an acute transforming retrovirus which is designated as simian sarcoma virus (SSV). Primarily, the viral genome was molecularly cloned in Aaronson's Laboratory at National Cancer Institute, USA. Following this, we determined the nucleotide sequence of the cloned genome. Based on the nucleotide sequence—*sis*, the transforming gene of SSV was predicted to code for a protein with a molecular weight of 28,000. In order to identify this protein in cells transformed with the SSV, we chemically synthesised *sis* specific peptides based on the predicted amino acid sequence. We next made antibodies to these peptides in rabbits. Using these antibodies it was possible to immunoprecipitate 28,000 dalton SSV transforming protein in cells transformed with the virus. Thus, the SSV transforming protein was identified.

Functions of the protein

Detailed studies revealed that this SSV transforming protein is neither a protein kinase nor does it bind to guanosine nucleotides. The best approach was to match its predicted amino acid sequence with other proteins of known function whose amino acid sequences are known or predicted. Therefore, we then tried to match the predicted amino acid sequence of *sis* encoded protein with the sequence of other known proteins using computer matching programs. Initially, we could not find any sequence homology with proteins of known function. However, researchers from Harvard University and California Institute of Technology reported a partial sequence of a protein known as the platelet derived growth factor (PDGF). Doolittle, a protein chemist at University of California, San

EGF receptor—the faulty cell-division protein

THERE are about eight oncogenes which produce similar proteins having related amino acid sequences. Following the discovery of *sis* protein, researchers from the Imperial Cancer Research Fund Laboratories, London, Weizmann Institute, Israel and Genentech Inc., USA, identified another oncogene protein (*Nature*, 309, 5967).

Scientists at the above three centres have purified this protein which acts as a receptor for the epidermal growth factor (EGF). Subsequently, they matched the receptor protein with other known proteins using computer matching programs. To their surprise, the receptor found its look-alike in the protein product of another oncogene (*erb*-B) whose origin is erythroblastosis virus isolated from chicken. Further experiments revealed that the protein product of *erb*-B represents only a part of the normal epidermal growth factor receptor, as assessed from the data of the DNA sequence of *erb*-B gene.

It appears that the receptor protein made by the *erb*-B gene is crucially different from a normal receptor. The normal receptor usually spans the walls of a cell. The part which is exposed carries the actual binding site for EGF. The *erb*-B gene apparently instructs a cell to make only the part of the receptor which would send a signal to divide, from the receptor site to the inside of the cell. This part of the receptor probably lacks the control region that enables replication signal to be shut off. Thus, the presence of *erb*-B protein can well account for the wild growth and proliferation of cells characteristic of tumours.

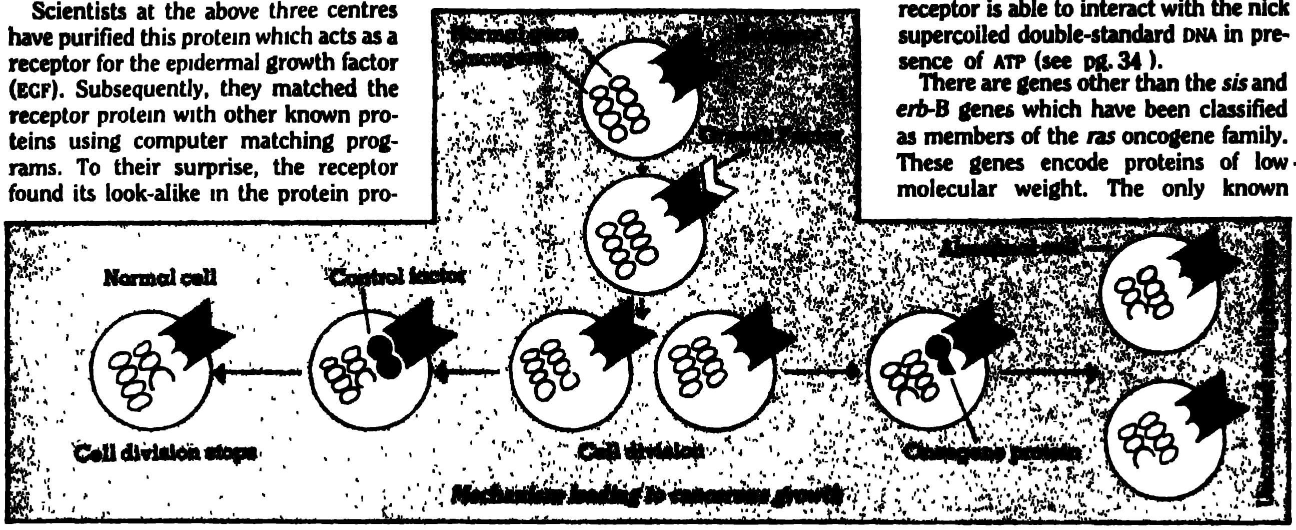
These findings correlate well with the report that certain brain tumours contain high concentrations of the EGF receptor in their membranes. This abnormal condition can explain the increased sensitivity of smallest quantities of growth hormone present in their vicinity, resulting in enhanced multiplication rate. Further studies carried out at National Institutes of Health (NIH) USA, suggest that certain growth factors released by human tumour cells bind to EGF receptor and keep the cells dividing.

The receptor for EGF has been identified as a transmembrane glycoprotein that has tyrosine kinase activity. However, the specific relationship between tyrosine kinase activity and control of growth and replication is not known. Studies carried out by Mroczkowski and his colleagues indicate that purified EGF receptor is able to interact with the nick supercoiled double-standard DNA in presence of ATP (see pg. 34).

There are genes other than the *sis* and *erb*-B genes which have been classified as members of the *ras* oncogene family. These genes encode proteins of low molecular weight. The only known biochemical property common to all forms of *ras* proteins is the ability to bind guanine nucleotides. A report (*Nature*, **310**, 5973) suggests that EGF enhances the guanine nucleotide binding activity of these proteins.

The findings of receptor proteins being responsible for initiating malignant growth, offers another approach in understanding cancer. Perhaps, with the development of immunoassays for these faulty proteins, detection of cancer will be easier.

Parul R. Sheth



Diego, using his computer program found that this partial amino acid sequence showed near-perfect match with oncogene *sis* encoded protein. Thus, for the first time, the product of a cancer gene was shown to be closely related or identical to an important protein with known physiologic function. This means, we have a clue for the mechanism by which a viral oncogene transforms a cell.

What is PDGF?

PDGF is known to have several functions, the most important being its role in wound healing. At the site of the wound, the platelets break open and release PDGF which stimulate the cells around the wound to multiply, thereby, healing the injury. When the wound is healed the PDGF brought at the site is now used up and the body functions normally. Contrarily, the SSV transformed cells express abnormal amounts of *sis* protein. Under the influence of *sis* protein which would have same or similar biological activity as that of PDGF, the cells would start multiplying. Unlike PDGF, uncontrolled amounts of *sis* protein would lead to cancerous growth.

In certain malignant human tumours like fibrosarcomas and osteosarcomas, there is an abnormal expression of *sis* related sequences. This is similar to SSV transformed cells where there is an abnormal expression of *sis* or PDGF related protein. It has been reported that some of these tumours release proteins similar to PDGF. Also, the normal counter parts of these tumours, have receptors for PDGF. Therefore, we now have means to understand the process of oncogenes by abnormal expression or activation of a gene with normal physiologic function.

Once the products of oncogenes are identified and the mechanism by which they induce tumours is determined, it should be possible to develop methods to interfere or even stop the biological activity of these proteins. From the experimental results it is heart warming to see that we are getting closer to the day when we will have means to conquer cancer. □

Dr. Devare is a research scientist working in Molecular Biology Division, Abbott Laboratories, Illinois, USA.

TINTED TONES

Gillian Valladares

DO YOU look at life through 'rose-tinted glasses', or are you 'feeling blue' and need to 'add some colour to your life'? Colour affects the way we *look* at life and even the way we *hear* things, for sound has colour too—the timbre of music. Colour is a universal language and a powerful descriptive tool, in all spheres of life and science is no exception. Scientific terminology has many 'colourful' components. This month we present a spectrum. Answers on page 74 and 75.

(1) Red spot:
- (A) A red star of low luminosity
- (B) Hubble Effect
- (C) A semi permanent marking of Jupiter
- (D) A hot giant star

(2) Orange lake:
- (A) A pebbled film surface
- (B) A multileaved grab bucket
- (C) A dyestuff
- (D) Orange pigments

(3) Yellow salt:
- (A) Piment, A_2S_3
- (B) Wulfenite, Pb MoO_4
- (C) Mercuric oxide HgO
- (D) Uranyl nitrate $UO_2(NO_3)_2$ $6H_2O$

(4) White rainbow:
- (A) Milky weather
- (B) A tropical squall
- (C) Bubbles formed by a breaking wave
- (D) Fogbow

(5) Green's dyadic:
- (A) A vector operator
- (B) A function associated with a given boundary value problem
- (C) Formulas obtained from Green's theorem
- (D) A theorem dealing with partial derivatives

(6) Silver fish:
- (A) Insects of the order *Thysanura*
- (B) Superficial argentophilic protozoans
- (C) A photographic print made with silver halides
- (D) A process causing reduction in insulation resistance and dielectric failure

(7) Blue bottle:
- (A) Plants of the genus *Edymion*
- (B) Lupine
- (C) Portuguese man-of-war
- (D) A blue-gray mudstone

(8) Graywacke:
- (A) A non selective radiator
- (B) A casing of gray iron
- (C) A process to polymerize diolefins
- (D) An argillaceous sandstone

(9) Gold leaf:
- (A) Treated cattle membrane
- (B) A unit for standardisation of angiotonin
- (C) Members of the division *Chrysophyceae*
- (D) Gold, rolled or beaten into fine sheets

(10) Black widow:
- (A) A venomous spider
- (B) A noctuid moth
- (C) An aquarium fish
- (D) A herbaceous plant

Continued from page 31

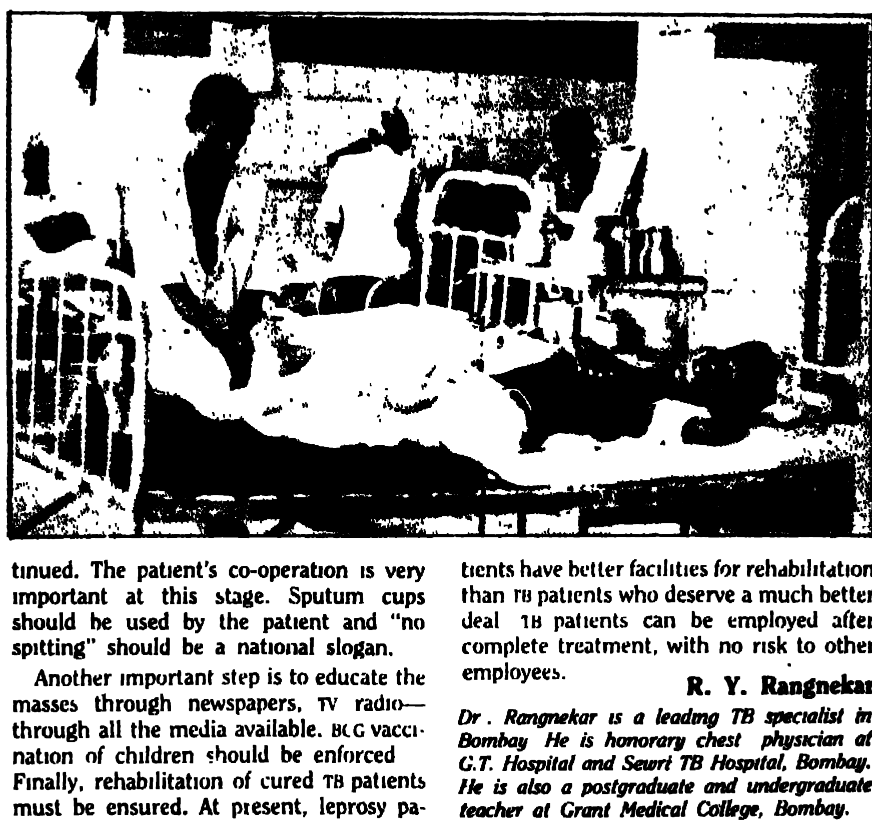
Doctor is TB controlled in India?

The last National Survey of the incidence of TB in India was taken in 1958. So no definite statistics can be given about present trends But in spite of the growth in population, the number of fresh cases is decreasing so some control has been definitely achieved.

What preventive measures would you suggest?

In any infectious disease there are five principles of prevention. The first is to find out the extent of the infection in the population this is done by mass miniature X rays (small X-rays which can be taken at the rate of one every minute), sputum examination, mass tuberculin testing of children and other methods

The second step is to isolate the infectious cases. This is not practicable as the number of hospital beds for TB patients are very few in comparison to the incidence of the disease in India. But with modern drugs, the patient becomes non-infectious in about three to four weeks and there is no danger. But the treatment must be continued. The patient's co-operation is very important at this stage. Sputum cups should be used by the patient and "no spitting" should be a national slogan.



S. M. KULKARNI

Another important step is to educate the masses through newspapers, TV radio—through all the media available. BCG vaccination of children should be enforced Finally, rehabilitation of cured TB patients must be ensured. At present, leprosy patients have better facilities for rehabilitation than TB patients who deserve a much better deal TB patients can be employed after complete treatment, with no risk to other employees.

R. Y. Rangnekar

Dr. Rangnekar is a leading TB specialist in Bombay He is honorary chest physician at G.T. Hospital and Sewri TB Hospital, Bombay. He is also a postgraduate and undergraduate teacher at Grant Medical College, Bombay.

Soybean and its many products are flooding our markets. Besides combating malnutrition, enhanced soybean production can make significant contributions to the economy

SOYBEAN

"GUESS who's coming to dinner?" This announcement by the husband at the end of a day need not create panic in the housewife. A sumptuous vegetarian meal can be easily dished out by a resourceful wife. Alternatively, even with a small quantity of *kheema* or mutton, a good dish can be prepared. The meal, both vegetarian and non-vegetarian, can be tasty and highly nutritious. The trick is to possess soybean products, either in the form of chunks or in granular form.

Soybean and its many preparations have become increasingly popular judging from the number of new products flooding the markets. We have soy flour, soy dal, soy oil, soy milk and a host of other products going under different brand names like *Nutrella*, *Meal Maker*, etc. But still a large section of our population is unaware of its nutritive value, not to speak of its good taste and special flavour.

The nutritive value of soybean is realised by several countries like Brazil, Mexico, Romania, Paraguay and Argentina. They have made rapid progress in increasing their soybean production and acreage. India too has joined the 'soybean race' in its agricultural expansion programmes. Developments on agricultural front, industrial processing and marketing of soybean in India suggest that demand for soybean is gradually growing. There is an advance knowledge and experience in technology and an increasing awareness, albeit slow, among consumers of the potential uses of soybean. At present, private and vanaspati industries are mostly utilising soybean produce in the preparation of soy products.

But advance in India has been slow in comparison to other countries. The area under soybean cultivation about a decade ago was hardly 1,25,000 hectares with a total production of approximately 87,500 tonnes having an average yield of 700 kg/ha. It has gone up to 2,80,000 hectares in 1978-79, and there is an ambitious target of 8,90,000 hectares to be placed under soybean cultivation by the end of sixth plan. Most of soy cultivation is in Madhya Pradesh and Uttar Pradesh. The introduction of improved varieties increased the average yield of soybean to about 1,000 kg/ha. While the overall production in India was about 3.5 lakh tonnes in 1978-79, the total production in the three leading soybean-producing countries, USA, Brazil and Argentina for 1978-79 was 83 lakh tonnes. The present production in this country is quite insufficient to cope with its requirements and the shortage of soybean oil is being met by imports every year.

Food potential of soybean

Soybean is one of the most nutritious pulses. It is rich in proteins, oil and mineral salts. It consists of approximately 40 per cent protein, 26 per cent carbohydrates, 20 per cent oil, 4 per cent minerals and 2 per cent phospholipids. It is a good source of phosphorus and lecithin, and thus could be used for the cure of nervous diseases. Soy flour in diet is specifically useful to diabetic patients because of its low carbohydrate content. Soybean contains sufficient amount of both water and fat soluble vitamins. Soy proteins are considered to be nutritively comparable to animal proteins, except for low methionine content, a sulphur-containing amino acid. No wonder, often soybean is referred to as 'meat for vegetarians'.

Soybean is a popular foodstuff used in various forms, in different countries. It is widely used as a protein food, oil seed crop and fodder crop. Besides, it has industrial uses and is utilised as gelling and aerating agent in the preparation of meat analogs, gravies, sauce, tempeh and animal feed. According to the 1978 report of the Food Protein Council-USA, over one billion kilogrammes of edible soy protein products are annually consumed in USA. During recent years, protein intake in USA has considerably increased with rapid growth in consumption of soy foods and other vegetarian protein sources. In Japan, per capita intake of protein from soy is 10 g/day, and in some southeast Asian countries, it is about 30 g/day.

In India, 'dal' is a favourite dish used either with *chapaties* or rice. Previously it was not possible to replace pulses by soybean as 'dal' because of its poor cooking- ability and undesirable taste. But pre-treatment of soybean has taken care of these problems thus, improving the quality of our diet.

Processing of soybean for the preparation of pre-cooked and dehydrated beans like other beans, as practised in USA and other countries, could provide great relief to the Indian women. Roasted soybean, free from beany flavour and undesirable taste, could serve as a high protein snack food and could be consumed like parched grams or roasted groundnuts. It could also be used as a valuable protein-enriching supplement in the candy industry. Soybean could also be used as sprouted beans like other food legumes, a common practice in Indian cooking.

Soy flour

For further improving the nutritional value of wheat products, soy flour has been supplemented because of its high protein and lysine, an essential amino acid, content. Today high protein baby foods and preschool children foods containing soy flour are quite common in India, eg *Bal-Ahar* and *Bal-Amul*. The practice of using pulse flour like Bengal gram, green gram and black gram in the form of *besan* or *chana atta* for mixing with cereal flour in various proportions for *chapaties*, *puris* and other tasty preparations is common in India. Processed soy flour could also be used for such preparations.

Green beans of soybean (*Hardee* variety) have been used for popularising south Indian dishes such as *uppitu*, *husli*, *thovi* and *sambar*. JS-2 and cooker type varieties of soybean are found to be good for blending with potatoes for making vegetable cutlets. Replacement of pulses by soybean up to 75 per cent in preparing *thalipith* and by 50 per cent in preparing *idli* improves the palatability of these preparations. However, replacement by 50 per cent in case of *dosa* causes slight deterioration in the acceptability, whereas replacement by 25 per cent does not adversely affect the palatability of cakes, *khurma*, *namkin* and *khurma-meetha*.

Marketing of soy flour could be realistically based on its properties such as water absorption, doughmixing – tolerance, colour, texture, flavour and other physical properties. There is a wide range of baked and confectionery items in which soy flour is used. It has been shown that five per cent incorporation of soy flour does not affect structure of bread, whereas 20 per cent level is safely recommended for other baked products

Soy flour is also being commercially processed these days for beverages, soy ice-creams, soy candy, extrusion cooked products, weaning foods and soy nuts.

Soy flour is also used as a protein source for growth of fungus in producing antibiotics like streptomycin, penicillin, tetracycline and erythromycine. The annual demand for soy flour by the antibiotic industry in India exceeds 10,000 tonnes.

Soy Production and Research Association (SPRA) at Bareilly, UP, has been marketing soya products on a commercial scale. The products include *'Nutri Nugget'*, based on 100 per cent defatted flakes (50 per cent protein), *'Protein Plus'*, a weaning food extruded and ground from maize and defatted soy flour, and *'Protesnac'*, a soy rice snack containing 15 per cent protein. Other soy-feeding products of SPRA include *'Nutriahar'* (full fat extrusion-cooked soy flour), *'Paushtikahar'* (soy-maize--sugar mixture) and *Soy Panjeeri'* (a mixture of soya flour, wheat, sugar and banana flavour). *Nutri Nuggets* as a vegetable and *Nutri Nuggets* panir (cheese) made from soybean protein have become popular, especially among vegetarians in India.

There is a substantial demand of soy products from poultry and animal feed industry too At present, the defatted soybean cake is being exported for animal feed to S.E. Asia, Europe and African countries.

Soymeal concentrate and isolate

Soymeal is processed to prepare soy concentrate (containing 68 per cent protein) and soy isolate (containing 92 per cent protein) to be used as a supplement for enriching proteins or for breakfast cereals, beverage powder and meat bits. Incorporation of the isolate in meat bits improves the dehydration property of cooked meat bits. Popularising a blend of wheat flour with soy flour or soy protein isolate or concentrate is an important approach for combating the problem of protein-calorie malnutrition.

Soy milk

In China and Japan soybean has been

S.N KULKARNI

popular for its specific use as soy milk and milk products to be used for daily consumption. Soy milk is extensively used for feeding infants in China. Soy cheese and curd are also prepared from soy milk. A start has also been made in India to popularise such products. Indeed, soy milk production has a great scope since the demand of people for milk in different parts of the country has not been met. In the hills particularly when the milk supply is in short supply, soy milk may meet the requirement.

Use of soy milk is also a boon for some children who are allergic to cow's milk. Its simple method of preparation and its diversified uses are encouraging factors for widespread use. In Maharashtra, a small plant has been set up to produce soy milk and soy curd. Soy milk fortified with vitamins and minerals promotes good growth

Fermented foods

A number of fermented soy products have been found to be acceptable to people. Some important ones include Soy Sauce, Miso, Natto and Tempeh. They are commonly used as dietary items in China, Japan, Korea and Indonesia Miso is a popular food in Japan for making soups Natto is used as a side dish. Tempeh has a high nutritive value and is easily digestible Cheese and cheese spread fermented soy foods are also used

Soy oil

Soy oil is being extensively used in vanaspati industry in India It has also industrial uses in the making of cosmetics, paints, varnishes, enamels, inks, stains, oil cloth, soaps, etc In USA, it is the chief edible oil for making margarine and for shortening purposes. In recent years, soy oil demand has substantially increased, and this is being met by imports from USA

Soy oil is a good source of edible lecithin for use as a food emulsifying agent in bread and other bakery products, in chocolate and pharmaceutical products. Incorporation of soy lecithin in the dough keeps *chapaties* soft and fresh for a longer time. This property may be of particular interest to the defence services which are interested in the preservation of *chapaties*.

Future scope

The future of soybean is bright. But it would greatly depend on the development of other industries for proper soybean utilisation in the preparation of various soybean products and beverages, and also in the development of animal and poultry feeds For this purpose, efforts of food technologists, industrial engineers, nutritionists and home economists are needed. Catering training institutes, too, have an important role to play by training people on the use of countless food products prepared from soybean.

Exploitation of soybean for supplementing the cereal-based diet can help in combating the problem of protein-calorie malnutrition In Israel and Columbia, addition of five per cent soy flour in bread has been made compulsory by law A similar step may greatly help the soybean development programme in India too Modern Bakeries Ltd (India) has been fortifying bread with soy flour

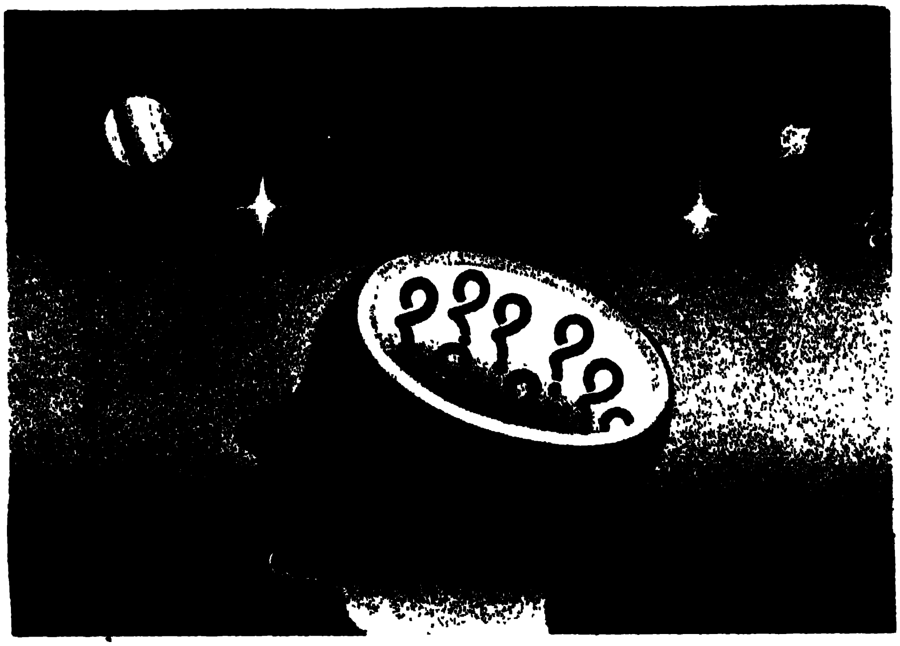
Balanced development of agricultural and industrial sectors can greatly enhance soybean production in the country Besides combating malnutrition, the country's economy will improve since at present we are spending crores in foreign exchange on importing soybean oil

Y. P. Gupta

Dr Gupta is a senior scientist at the Indian Agricultural Research Institute, New Delhi.

MODELLING THE MIND

Joseph Weizenbaum



SOMETIMES a very complex idea enters the public consciousness in a form so highly simplified that it is little more than a caricature of the original, yet this mere sketch of the original idea may nevertheless change the popular conception of reality dramatically. For example, consider Einstein's theory of relativity. Just how and why this highly abstract mathematical theory attracted the attention of the general public at all, let alone why it became for a time virtually a public mania and its author a pop-culture hero, will probably never be understood. But the same public which clung to the myth that only five people in the world could understand the theory, and which thus acknowledged its awe of it, also saw the theory as providing a new basis for cultural pluralism, after all, science had now established that everything is relative. A more recent example may be found in the popular reception of the work of F. Crick and J. D Watson, who shared the Nobel prize in Medicine in 1962 for their studies of the molecular structure of DNA, the nucleic acid within the living cell that transmits the hereditary pattern. Here again highly technical results, reported in a language not at all comprehensible to the layman, were grossly oversimplified and overgeneralized in the public mind into the now-popular impression that it is already possible, to design a human being to specifications decided on in advance What these two examples have in common is that both have introduced new metaphors into the common wisdom

Often the heuristic value of a metaphor is not that it expresses a new idea, which it may or may not do, but that it encourages the transfer of insights, derived from one of its contexts, into its other context Its function thus closely resembles that of a model

The results announced by Crick and Watson fell on a soil already prepared by the public's vague understanding of computers, computer circuitry, and information theory (with its emphasis on codes and coding), and, of course, by its somewhat more accurate understanding of Mendelian genetics, inheritance of traits, and so on Hence it was easy for the public to see the "cracking" of the genetic code as an unraveling of a computer program, and the discovery of the double-helix structure of the DNA molecule as an explication of a computer's basic wiring diagram. The coupling of such a conceptual framework to one that sees man as a physical object virtually compels the conclusion that man may be designed and engineered to specification.

The example from molecular biology illustrates an overextension of a metaphor in another sense; there the extent of what we know about the human as a biological organism is vastly exaggerated The result is, to say the least, a premature closure of ideas. The metaphor, in other words, suggests the belief that everything that needs to be known is known

The computer has become a source of truly powerful and often useful metaphors Curiously, just as with the examples already cited, the public embrace of the computer metaphor rests on only the vaguest understanding of a difficult and complex scientific concept (here, the theory of computability and the results of Turing and Church concerning the universality of certain computing schemes) The public vaguely understands –but is nonetheless firmly convinced – that any effective procedure can, in principle, be carried out by a computer. Since man, nature, and even society carry out procedures that are surely "effective" in one way or another, it follows that a computer can at least imitate man, nature, and society in all their procedural aspects. Hence everything (that word again!) is at least potentially understandable in terms of computer models and metaphors. Indeed, on the basis of this unwarranted generalization of the words "effective" and "procedure", the word "understanding" is also redefined To those fully in the grip of the computer metaphor, to understand X is to be able to write a computer program that realizes X

One area of psychology was extraordinarily well-prepared to benefit from a fusion with the kind of process-oriented thinking characteristic of computer scientists, it was the area which concerns itself with the cognitive processes underlying the acquisition and memorization of information An enormous amount of laboratory work had been done on, for example, the task of memorizing so-called nonsense syllables. One form of an experiment that has been performed by countless psychological laboratories is to present a subject with, say, a dozen pairs of three-letter syllables, one pair at a time, and to ask him, on each (but the first) presentation of the first of the pair, to say what the second is. The syllables are carefully chosen to be inherently meaningless Thus, for example, CAT is not a nonsense syllable, but PAG is. Subjects are exposed to the list, one pair at a time, repeatedly until they are able to give the correct response item to each stimulus item. Edward S. Feigenbaum reported:

"The phenomena of rote learning are well-studied, stable, and reproducible. For example, in the typical behavioural output

We present exclusive excerpts from a controversial and much-acclaimed critique of computers by one of the world's topmost computer scientists, the man who invented the ELIZA programme

of a subject, one finds:

a. Failures to respond to a stimulus are more numerous than overt errors.

b. Overt errors are generally attributable to confusion by the subject between similar stimuli or similar responses.

c. Associations which are given correctly over a number of trials sometimes are then forgotten, only to reappear and later disappear again. This phenomenon has been called oscillation.

d. If a list of x of syllables or syllable pairs is learned to the criterion; then a list y is similarly learned; and finally retention of list x is tested; the subject's ability to give the correct x response is degraded by the interpolated learning. The degradation is called retroactive inhibition. The overt errors made in the retest trial are generally intrusions from the list y. The phenomenon disappears rapidly. Usually after the first retest trial, list x has been relearned back to criterion.

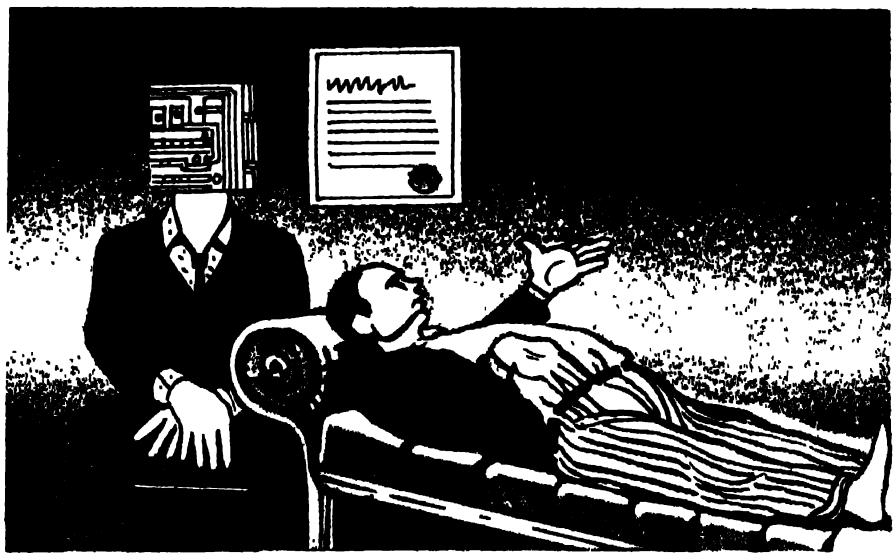
e. As one makes the stimulus syllables more and more similar, learning takes more trials."

Feigenbaum, currently a professor of computer science at Stanford University, conjectured that this sort of learning task involved the subject in an active, complex symbol-manipulation pro-elementary symbol-manipulation processes of just the kind that can be programmed for a computer.

Of course, nothing would have been easier than to write a small program for a computer which would have enabled an experimenter to give the computer lists of nonsense syllables that the computer could then reproduce perfectly after the first trial". The task Feigenbaum set for himself harder: to produce, in the form of a computer program, a model of cognitive processes whose over-all behaviour would closely approximate that of human subjects engaged in memorizing nonsense syllables, and whose detailed internal functions would constitute a theoretical explanation of the difficulties actually observed in experiments. Moreover, he wished his explanations to be at least consistent with such psychological observations as, for example, that humans have both short-term memories, in which they can apparently hold a few symbols for instant recall during a short period of time, and longer-term memories, in which an almost unlimited amount of information can be stored but from which individual items can be retrieved only at the expense of some effort. If this "effort" to remember is thought of as the computational effort involved in executing a perhaps long sub-routine, it becomes obvious how one can begin to apply the computer metaphor.

Feigenbaum's central idea is for the computer to store *descriptions* of the syllables presented to it, not the actual syllables themselves. The syllable DAX, for example, may be described by the fact that its first letter has a vertical leading edge and contains a closed loop, that its second letter contains a horizontal middle bar, and so on. When a syllable is first presented to the system, a description of it just sufficiently detailed to allow it to be discriminated from the syllables already stored is added to storage. If it is a stimulus item, that is, the first of a syllable pair, then a "cue" consisting of a minimal description of the syllable with which it is to be associated is stored with it. Because all these descriptions are so minimal, the system often makes wrong associations when presented with stimulus items. But because the correct response item is presented whenever the system makes such an error, the descriptive information then in play may be improved by adding further description to it. Eventually the system learns the list perfectly. When another list is then attempted, the descriptions associated with it may again be confused with those corresponding to the first list, and vice versa. The system is thus capable of exhibiting retroactive inhibition. And clearly, as the items to be learned are made more and more similar to one another, an increasing number of trials is required to refine the discriminating power of each relevant descriptor. The system thus behaves very much as does a human confronted with the same task.

Feigenbaum's program, though by now very old (it was completed in 1959), remains instructive in at least two respects. First, it offers us a relatively simple example of what is meant by a model of a cognitive process in computer-program form. The way it organizes its information storage is meant to be a functional description of the human intermediate-term memory. As such, it explains, for example, how it may be that we can totally forget something for a long time and yet recall it again under certain circumstances. It cannot be that the allegedly forgotten item was simply wiped out of our minds, for if it were, we could never regain access to it. In Feigenbaum's model no information is ever destroyed. But information may be hidden, so to speak, by descriptors leading to other associations; thus one memory may screen or mask another. Sometimes a refinement of the screening image (that is, of a cue) is, in Feigenbaum's system, all that is required to uncover (that is, to make again accessible) what was previously masked.



Feigenbaum's system also requires that the two syllables to be associated with one another be simultaneously available to the computer (that is, present in its store) for a short time. After a "cue" to the response item has been associated with the description of the stimulus syllable, the two syllables per se can be erased from the computer's store—in other words "forgot-

ten". There is thus a part of his system that plausibly corresponds to what little psychologists know about the function of the human short-term memory No one, least of all Feigenbaum, claims that his model constitutes "the" explanation for such phenomena. But it is an explanation in a domain where explanations are rare.

The second respect in which Feigenbaum's program is instructive is that it behaves in ways which were not directly and deliberately "programmed in", as the saying goes. For example, the program exhibits what psychologists call interference; that is, the acquisition of a new association interferes with the production of an older one when the syllables involved have closely similar descriptions. The program contains no interference subroutine as such. The phenomenon arises as a consequence of the entire structure of the program, and appeared as a surprise to its designer. In that respect, then, the model *predicted* a behavioral phenomenon, which enormously enhanced its plausibility. The program thus instructs us that the easy and much-repeated slogan "a computer does only what its programmer told it to do" is in certain respects quite wrong and is in any case problematical.

The program we have been discussing is a member of a class of programs called "simulation programs". Their object is to simulate the way humans accomplish certain tasks, but decidedly not to accomplish those tasks in the most efficient way a computer possibly could We have noted, for example, that a computer could easily be programmed to "memorize" lists of nonsense syllables in one "trial" But that would teach us nothing about how humans might accomplish what appears at least superficially to be the same task.

The modern literature on problem solving is punctuated by two important books, George Polya's *How to Solve It* and Newell and Simon's *Human Problem Solving*

What Newell and Simon were later to call "the means- ends method" was first suggested when the way an early version of their logic-theory machine proved theorems was compared with recordings of "thinking aloud" sessions of nonmathematics students attempting the same tasks These so-called protocols proved highly suggestive for further work Protocol taking, that is, watching other people solve problems, became virtually a hallmark of Newell and Simon's procedure

The new information-processing psychology proceeds from the basic view

"that programmed computer and human problem solver are both species belonging to the genus 'Information Processing System' (IPS)...

"When we seek to explain the behaviour of human problem solvers (or computers for that matter), we discover that their flexibility—their programmability—is the key to understanding them. Their viability depends upon their being able to behave adaptively in a wide range of environments....

"If we carefully factor out the influences of the task environments from the influences of the underlying hardware components and organization, we reveal the true simplicity of the adaptive system. For, as we have seen, we need postulate only a very simple information processing system in order to account for human problem solving in such tasks as chess, logic, and cryptarithmetic. The apparently complex behaviour of the information processing system in a given environment is produced by the interaction of the demands of that environment with a few basic parameters of system, particularly characteristics of its memories

"Matters are simple, not because the law of large numbers cancels things out, but because things line up in a means-ends chain in which only the end points count (i e equifinality) "

An information-processing system is therefore, in this context, a hardware computing system together with a program capable of executing eip's on stored symbol structures. It has, of course, input-output equipment, such as console typewriters, that enable adequate communication with the world outside itself.

The most ambitious information-processing system that has been built for the purpose of studying human problem-solving behaviour is Newell and Simon's *General Problem Solver* (GPS).

"The main methods of GPS jointly embody the heuristic of means-ends analysis-....Means-ends analysis is typified by the following kind of commonsense argument: I want to take my son to nursery school. What's the difference between what I have and what I want? One of distance. What changes distance? My automobile. My automobile won't work. What is needed to make it work? A new battery. What has new batteries? An auto repair shop. I want the repair shop to put in a new battery: but the shop doesn't know I need one. What is the difficulty? One of communication. What allows communication? A telephone ..and so on.

This kind of analysis—classifying things in terms of the functions they serve, and oscillating among ends, functions required, and means to perform them—forms the basic system of heuristic of GPS. More precisely, this means-ends system of heuristic assumes the following·

1. If an object is given that is not the desired one, differences will be detectable between the available object and the desired object.
2. Operators affect some features of their operands and leave others unchanged. Hence operators can be used to try to eliminate differences between the objects to which they are applied and desired objects.
3. If a desired operator is not applicable, it may be profitable to modify its inputs so that it becomes applicable.
4. Some differences will prove more difficult to affect than others. It is profitable, therefore, to try to eliminate 'difficult' differences, even at the cost of introducing new differences of lesser difficulty. This process can be repeated as long as progress is being made toward eliminating the more difficult differences."

To see how this works on one of the kinds of problems to which GPS has actually been applied, consider the following cryptarithmetic puzzle:

$$\begin{array}{r} DO \\ +\ IT \\ \hline TTD \end{array}$$

A subject is told that the above is an encoding of a problem in ordinary addition. Each letter represents a number, and no two letters represent the same number. His task is to assign numbers to the letters in

such a way that the given expression represents a correct addition. He is to produce a protocol, that is, to say out loud what he is thinking. Following is one possible such protocol, interspersed with an analysis in GPS-like terms:

Subject: D + I must be greater than 9 because there is a carry to the next column.

Analysis: The subject applied the operator "process column".

Subject: T must be 1 since it is a carry.

Analysis: The subject applied the operator "assign value". He has reached a subgoal and reduced the difference between the given and the desired object. The "given object" is now

```
   DO
+  II
-----
  1ID
```

Subject: 0 must be at least 2.

Analysis: The subject applied the operator "generate possible values" to 0. (There must have been some unspoken tentative application of the operator "assign value" whose results were rejected.)

Subject: Let's try 0 = 2.

Analysis: The subject applied the operator "assign value". Another reduction of difference. The "given object" is now

```
   32
+  II
-----
  113
```

Subject: 1 = 8.

Analysis: The "assign value" operator is applied and the difference between the given object and the desired object removed. The goal is reached.

This is a much simpler problem than those typically given to subjects and the GPS. A much more typical example of a problem that has been fully analyzed is

```
   DONALD
+  GERALD
---------
   ROBERT,
```

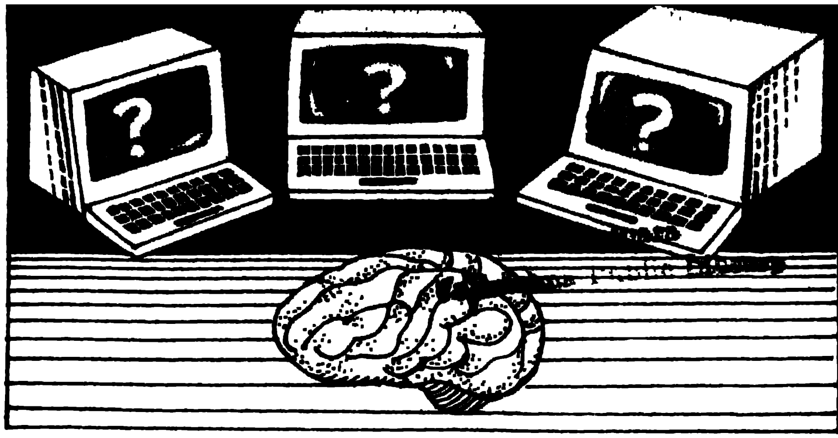


ILLUSTRATION BY M.S. TALWALKAR

where D = 5. The example we have worked out suffers from the additional fault that it does not display any wrong moves, backtracking, and so on. Nevertheless it gives a general, if pale, idea of the way GPS works and of what a protocol is.

It should also be understood that GPS is not the model of Newell and Simon's theory. GPS implies more about a distinct level of generality independent of the tasks to be accomplished than their theory requires. Indeed, there does not exist any one computer program that is a model of their theory. Instead there exists a number of programs, by no means all of them composed by Newell and Simon or their coworkers, that are substantially consistent with the theory and that employ the "main methods of GPS" listed above. It is the information-processing theory of man which concerns us here, not GPS as such. And we are concerned with that theory precisely because it, in one variation or another, sometimes explicitly and sometimes implicitly, underlies almost all the new information-processing psychology and constitutes virtually a dogma for the artificial-intelligence community.

The basic conclusions the theory reaches are the following:

"All humans are information processing systems, hence have certain basic organizational features in common, all humans have in common a few universal structural characteristics, such as nearly identical memory parameters. These commonalities produce common characteristics of behaviour among all human problem solvers.

"Since the information processing system (i.e. the human seen as an information-processing system—J. W.) can be factored into (1) basic structure, and (2) the contents of long-term memory (i.e., programs and data), it follows that any proposal for commonality among problem solvers not attributable directly to basic structure must be represented as an identity or similarity in the contents of the long-term memories in the production system or in other stored memory structures."

(The theory) "proposes a system that, given enough time, can absorb any specification whatsoever—can become responsive to the full detail, say, of an encyclopaedia (or a library of them). Hence the theory places the determination of differences and similarities of behaviour directly upon the causes defining the content that will be stored in the human long-term memory. But these determinants of content are largely contingent upon the detail of the individual's life history. This does not mean that the determining processes are arbitrary or capricious or unlawful. It means that the contents can be as varied as the range of physical, biological, and social phenomena that surround the individual and from which he extracts them."

The dream of the artificial intelligentsia—a happy phrase the world owes to Dr. Louis Fein—is, of course, to bring into the world "machines that think, that learn, and that create", and whose ability to do these things will increase until "the range of problems they can handle will be coextensive with the range to which the human mind has been applied".

Of course, this euphoric promise is predicted precisely on a view of man as a GPS-like machine. As Dr. Colby said,

"A human therapist can be viewed as an information processor and decision maker with a set of decision rules which are closely linked to short-range and long-range goals.... He is guided in these decisions by rough empiric rules telling him what is appropriate to say and not to say in certain contexts."

The patient is, in other words, an object different from the desired object. The therapist's task is to detect the difference, using difference-detecting operators, and then to reduce it, using difference-reducing operators, and so on. That is his "problem"! And that is how far the computer metaphor has brought some of us. □

Excerpted from "Computer and Human Reason" by Joseph Weizenbaum, Penguin Books, 1984, price £2.95 (distributed in India by Penguin Overseas Ltd.).

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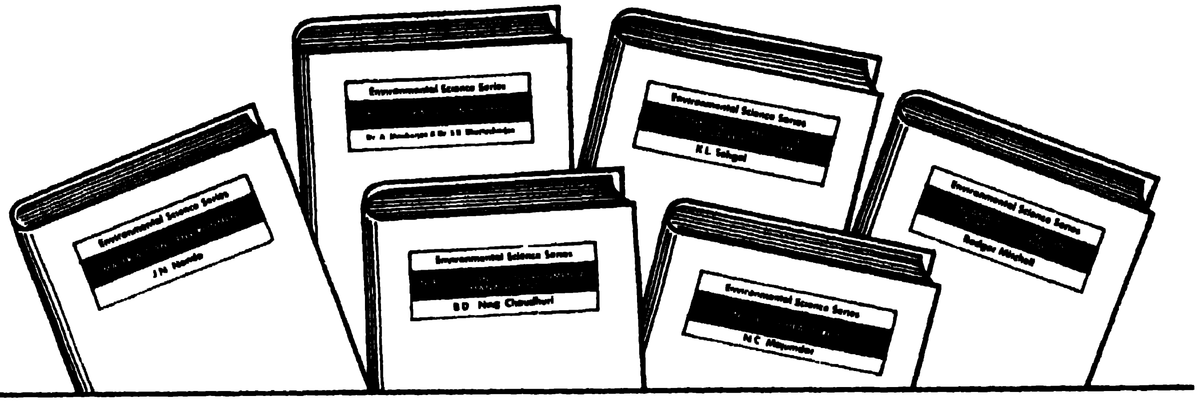

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Hexagon grid smoothens traffic flow

R. Subramanyan

ROADS and highways play a prominent role in our lives. For transport and communication they are indispensable. The ambitious developmental goals that we have set for ourselves make the integrated, standardised and automation-oriented roads inevitable. Hence the selection of a most advantageous road grid on which future roads could be built assumes importance.

Civil engineers have not experimented much with the available road grids because of their reluctance to break away from traditional approaches—right-angle crossing, long straight roads, convergence at focal places like palaces, temples, etc. However, the increasing demands of automation, high traffic densities and soaring costs of transport and route installation make it imperative to choose a road grid that primarily meets these demands and smoothens the flow of traffic.

A geometrical pattern, be it a triangle, square or hexagon, on which roads could be built is called a road grid. Take, for instance, four roads meeting at a junction. These could be so constructed that they form a boundary of blocks in a particular geometrical pattern.

We shall confine ourselves to three grid patterns--triangle, square and hexagon. These are known as pure grid patterns because they involve straight roads meeting symmetrically at all junctions in an identical manner and forming blocks, all of one regular shape and size. Table 1 gives the features of these three grids.

Travel in the grids

The simplest route between a start junction S and an end junction E involving a minimum travel distance can be identified in Figs. 1, 2 and 3. The route is marked with small circles. Taking the triangle grid (Fig. 1), from S take that road whose direction passes closest to E such that angle STE equals 120°. At T, turn and reach E. Similarly, for the square grid (Fig. 2) angle STE is 90°.

Unlike in the other two grids, in the hexagon grid (Fig. 3 on p. 48), straight line travel 'through' junctions is not possible. The main mode of travel in this grid is the "zigzag" mode, wherein one turns alternately left and right at successive junctions. One can take any of the three roads at the start junction S. But at the next junction one can start one of the two zigzags; one by turning left (then right, then left, etc) and another by turning right (then left, then right, etc). Thus six different zigzags are available from S.

The six broken lines drawn from S are repeatedly touched by one or the other of these zigzags at alternate turnings. They can, therefore, be taken as indicating the "general" direction of the zigzags touching them.

Six other zigzags are found at the end junction E. Two of these will intersect two zigzags from S, making an angle of 120° between the general directions. One of these two intersections is shown in Fig. 3 as T.

The simplest and shortest route from S to E, is a zigzag from S to T followed by a zigzag from T to E.

After identifying the minimum travel distance route for all the three grids, let us now consider the significant factors in choosing the best grid.

Table 1 Features	Triangle grid (Fig.1)	Square grid (Fig. 2)	Hexagon grid (Fig. 3)
Angle between adjacent roads	60°	90°	120°
Shape of blocks	Triangle	Square	Hexagon
Number of sides	3	4	6
Number of roads meeting at any junction	6	4	3

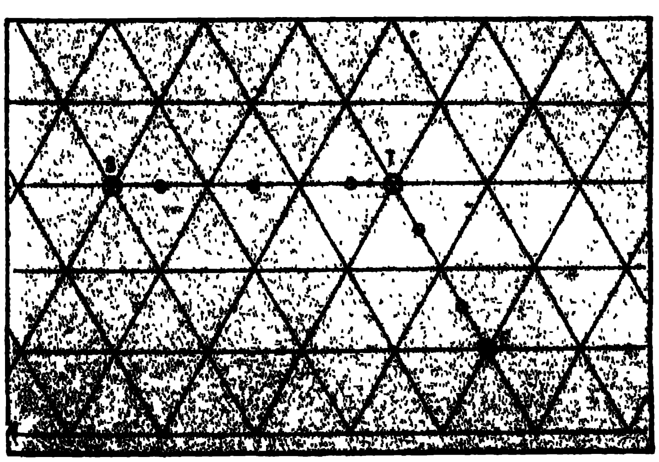


Fig. 1 The triangle grid

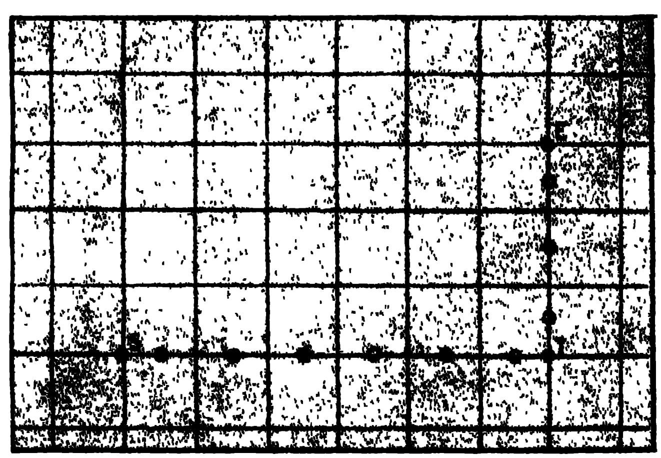


Fig. 2 The square grid

Route length factor R

For all types of service grids, the total length of the routes to be installed for unit area served will be a very important consideration, perhaps the most important. As this depends on the size of the blocks, we will compare grid patterns having blocks of the same area, say unit area. All portions of the routes of a grid are shared by two adjoining cells. The semi-perimeter of the unit-area block itself will thus be the route length factor R.

The lower the value of R, the shorter will be the total length of routes to be provided for a given area; and lower the capital cost of the grid. We have R equal to 2.24, 2.00, and 1.86 for the triangle, square and the hexagon grid, respectively.

Detour factor D

The minimum distance to be covered in moving from a point S on the grid to another, E, also on the grid along the routes of the grid will, in general, be more than the straight line distance SE. The ratio of the former to the latter may aptly be called the detour factor D.

D will vary, mainly with the orientation of SE with the grid directions. However, average values of D for large areas compared to the blocks can be arrived at for the three pure grids.

The lower the value of average detour factor, the more efficient or economical will be the grid in "operation". The average D for the triangle, square and the hexagon grid is 1.116, 1.296 and 1.289, respectively.

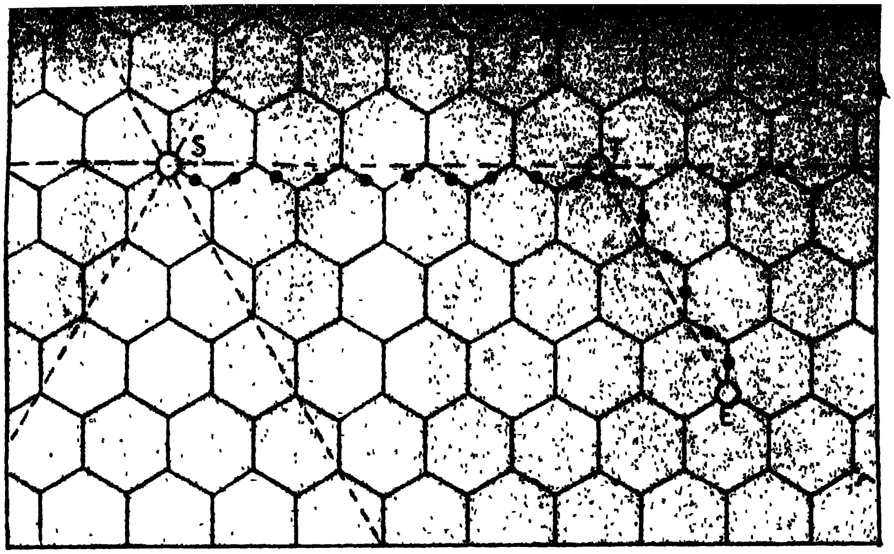


Fig. 3 The hexagon grid

Traffic intersection factor

This is an important factor for road and other grids involving "traffic".

Consider the square grid junction of four roads, A, B, C and D in Fig. 4 on p. 49.

The traffic in road A consists of two "road" streams (shown as thick lines with big arrows) one entering and the other leaving the junction. The road stream entering the junction at 'a', splits into three junction streams, ab turning left, ac going straight and ad turning right; and end up as parts of the 'leaving' road streams of B, C and D.

The road streams entering the junctions B, C and D follow the same pattern.

Thus a total of 12 junction streams (shown as dotted lines with vehicles on) are formed; four of which (ab, bc, cd and da) do not intersect any other stream. The remaining eight streams intersect one another at 16 intersections (shown as maroon dots). Table 2 gives results of similar considerations with the other two grids.

Table 2 System	Number of junction streams		Number of Total Intersecting
	Total	Intersecting	
(3 roads)	6	3	3
(4 roads)	12	8	16
6 roads)	30	24	120

The smaller the number of intersecting streams and intersections, the better—from many considerations, including traffic problems, cost of junctions and ease of automation.

Turning factor

In moving from one point to another along the grid routes, the fewer the turnings to be made, the better. The triangle grid comes first, the square grid, second, and the hexagon grid last, considering this factor. The weightage of this factor gets reduced if we consider traffic islands, traffic control, automation and the ease of the standard 120° turn of the hexagon.

Block space utilisation factor

Effective utilisation of the space in the blocks will depend upon their shapes.

The triangle block with its acute corners will be the least satisfactory one, while the hexagon block with obtuse angles the most satisfactory.

The aesthetic factor

For "visible" service grids—like the road grid—this factor deserves consideration.

After a look at the three figures, 1, 2 and 3, it is safe to conclude that the hexagon grid will be considered the most pleasing mainly because its smooth obtuse angles result in near-circular blocks. The triangle grid will be the least preferred.

The "merit ranks" of the three pure grids with respect to the various factors are given in Table 3 on p. 49.

Even without quantifying the

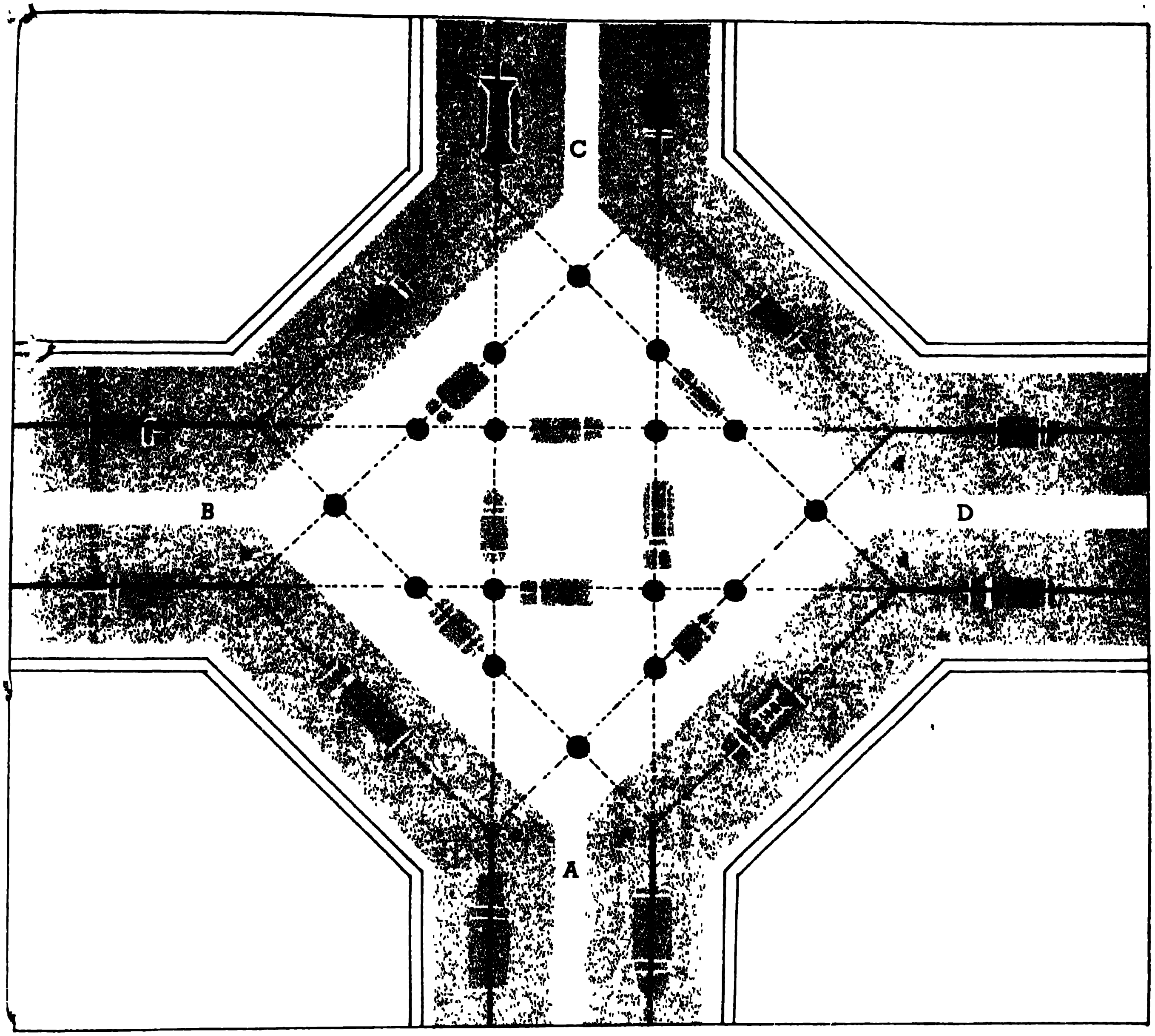


Fig. 4 The square grid junction of four roads

weightages for all the factors, we can reasonably conclude from Table 3 that the hexagonal grid is, on an "overall" basis, superior to the other two, and should be the choice for future service grids. In fact, the case for the hexagon is so strong that it is surprising that it has been ignored; especially, when we are constantly seeing that nature has adopted this shape extensively in its cellular structures.

Table 3	Merit ranks of grids		
Factor	▲	■	⬡
Route length	3	2	1
Detour (average)	1	3	2
Stream crossing	3	2	1
Turnings	1	2	3
Block space utilisation	3	2	1
Aesthetic	3	2	1

In view of the huge resources being spent on the development of all types of service grids, the earlier we consider the adoption of the hexagon grid, the better. □

Mr. Subramanyan is Deputy Chief Electrical Engineer at Durgapur Steel Plant, West Bengal.

LEUKAEMIA LAID LOW

Anuradha Sowani

MARCH 4, 1983: Vandana Kadam a young girl of nine was being admitted in a specially prepared room at the Tata Memorial Hospital, Bombay. Every care was taken to ensure that Vandana did not come in contact with any disease-causing organisms. Her clothes, bedsheets, curtains, pillow-cases—everything in the room was sterile. Even foodstuffs were irradiated before going in Vandana's room to kill all the bacteria. Only the doctor on duty and one nurse could go in the room at a time. They too had to change their clothes and footwear in a room partitioned off from the rest of the floor. Then they had to wash their hands, nails and face thoroughly, and change into a sterile gown, face mask and handgloves. Only then could they step in her room.

All these stringent precautions were being taken because Vandana was suffering from leukaemia. Leukaemia is a name given to a group of diseases characterised by an abnormal and excessive proliferation of leucopoietic cells throughout the body. The bone marrow and lymph nodes are the tissues of origin and maturation of white blood cells (WBC). In leukaemias, the WBCs are formed in excessive quantities, are abnormally developed and many immature forms escape into the general circulation.

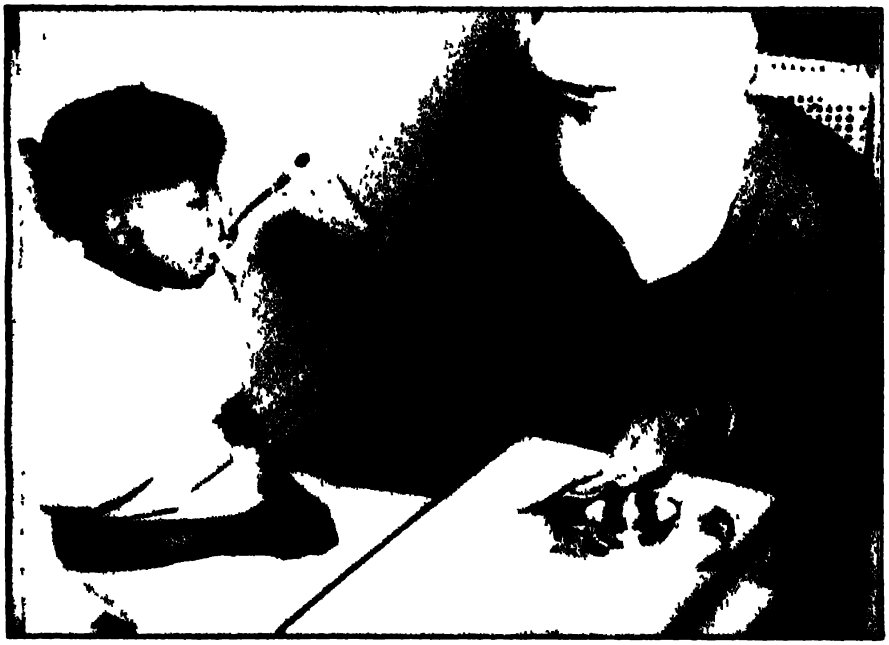
What causes the normally well controlled process of cell formation to go haywire? No one really knows. There are many hints though. Defective chromosomes could be one answer. Cytogenetic studies show chromosomal abnormalities in some forms of leukaemias. 'Philadelphia chromosome'—(an arm deleted or broken off from chromosome number twenty two) is characteristic of Chronic Myeloid Leukaemia (CML) Exposure to ionising radiation may produce chromosome damage and thus start the process of leukaemic changes in WBCs. After the atomic explosion, there was a phenomenal increase in the number of cases of leukaemias in Hiroshima and Nagasaki. Recently, viruses have been shown to be involved in causing leukaemias. Adult T cell leukaemia, both in Japan and in USA, was shown to be due to HTLV—Human T cell Lymphoma—leukaemia virus. (T cells are a specific subtype of WBC, involved in cellular immunity.) But for many leukaemias, no reason can be attributed.

So that was the disease that had caught Vandana Kadam in its vice-like grip. She had a loss of appetite, was growing weaker and paler every day. Her left eye had suddenly protruded out of the eye socket. On examination, the doctors found that her liver was enlarged and both eyes showed internal haemorrhage. So leukaemia was high on the list of suspects.

Her blood report confirmed the diagnosis. Her bone marrow was producing abnormal WBCs in excessive numbers. These WBCs were overflowing into the general circulation and going to all her organs. They were getting caught in the liver, spleen, lymph nodes, behind the eye ball—and growing abnormally fast at each place. The left eye was protruding because of the pressure of such a growing mass.

Since all the space in the bone marrow was occupied by the abnormal WBCs no room was left for the RBCs (red blood cells) and hence she had grown anaemic. Since the platelet number was low her blood could not clot effectively. So she was developing haemorrhages everywhere.

A chunk was then removed from her hipbone and examined under the microscope. It revealed the type of leukaemia she was suffering from—'Acute myelomonocytic leukaemia'.



A spoonful of sterile food for Vandana. Notice the extreme care—covered head and mask of the nurse-taken to avoid any infection to the young leukaemia patient

Treatment began in October 1982. Five different anti-cancer drugs were given in combination. These drugs were pretty strong. They killed most of the leukaemic cells. So in November, Vandana went in a remission. The percentage of leukaemic cells came down from 84 per cent to 5 per cent, and remained thus till February 1983.

But that was no cause for rejoicing, as that was not the end of her disease. Leukaemia is a recurring disease. Even if one leukaemic cell is left behind, it will divide, form many leukaemic cells which in their turn will beget many more. Unfortunately, the drug-therapy cannot be continued in sufficiently

large doses with the aim of killing the last leukaemic cell, as the side effects get worse and worse. The patient suffers more from the side effects than from the disease itself. Besides, the anti-cancer drugs are not as specific for leukaemic cells as one would wish. They attack all fast-dividing cells. So they kill the normal bone marrow, inner lining of the intestines, skin, etc. So obviously, drugs cannot be the last word in the treatment of leukaemias.

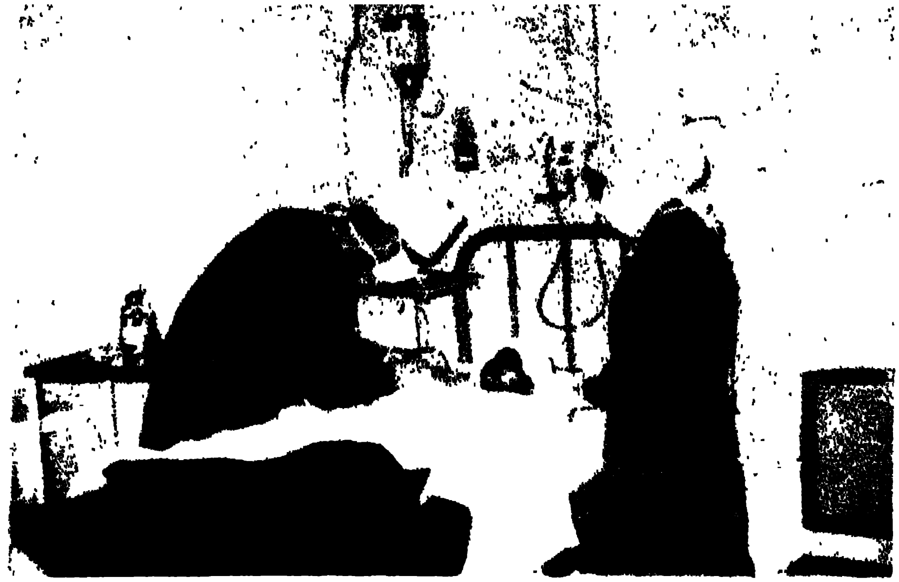
What is true of the anti-cancer drugs is true of radiation therapy also. Ionising radiations have adverse effects on cancer cells as well as surrounding normal cells. So radiation therapy has to be stopped beyond a certain limit.

Does that mean that killing the last leukaemic cell in a patient's body will remain an unattainable, elusive dream? No, it can be done but at the cost of killing off all the normal bone marrow along with the abnormal marrow. But there is a way out of such a tricky situation. After killing off the last leukaemic cell, the normal bone marrow can be replaced. Some one else's healthy marrow can be put inside the patient's body and it works just as well.

Such bone marrow transplants had succeeded in dogs and mice. They were tried out in human beings in 1950 but failed miserably. The patient's body recognised that the donor's marrow was not its own. Promptly, all the immunological mechanisms geared to ward off invasion by foreign material came into play and the graft was rejected. The foreign marrow would die off, and so did the patient.

Slowly, medical research unveiled mechanisms involved in recognising foreign material, and consequently, rejecting it. The discovery of HLA system (Histocompatibility system) was the turning point in bone marrow and other organ transplants.

The situation is similar to that of blood transfusion. Just as the blood is identified by the blood groups, the tissues, including the bone marrow, are identified by the HLA groups. Grafts bearing a different HLA marker is promptly destroyed by the host.



Doctors examine Vandana before the transplant. The gift of the life saving bone marrow to Vandana came from her brother (above) Umesh

There is only one exception to the rule—identical twins. They are identical in every respect, even their HLA types. So the doctors used identical twins for organ transplants—and it worked! There was no rejection at all. The patient's body accepted tissues from the patient's identical twin without turning a hair.

Slowly, many other helpful discoveries were made. Drugs that could control or suppress immunological reactions came to light. TPN, another major discovery, though rather unrelated to a bone marrow transplant, made such a transplant possible. TPN means total parenteral nutrition. While going through the rigorous procedures aimed at killing all the leukaemic cells, the patient's mucous membrane of the oral cavity and intestinal lining suffer heavily. The patient cannot swallow anything. Giving ordinary glucose preparations intravenously is no help, since the amount of calories that can be given in 24 hours are just not sufficient to fulfil the patient's every day energy requirements. Increasing the glucose percentage increases problems, since high level of glucose invites fungal and bacterial growth. To avoid all such problems, very high level of glucose, fats, proteins etc. can be put directly into the heart chambers—through a thick tube inserted in the neck veins. The blood flow near the heart is so speedy that glucose does not stagnate at one place, so there is no chance for harmful invaders to grow.

When HLA type differences and nutrition are taken care of, bone marrow transplant is possible even when the donor is not an identical twin of the patient.

Vandana was therefore called to Bombay for the tissue typing and matching tests along with her entire family. All the family members underwent many tests to decide their blood groups, general health and tissue types—mainly by the HLA typing method. Scientists at the Cancer Research Institute (CRI) at Bombay undertook all these tests. Out of four siblings, two matched exactly—Vandana and her younger brother Umesh (7½).

The HLA group composition of the Kadam family, father, mother and the

four children, was as given below:

Mr. Kadam		*Mrs. Kadam*	
A_9/B_{35}		A_9/B_{12}	
A_1/B_{15}		A_{19}/B_7	
Vandana	*Sharda*	*Suresh*	*Umesh*
A_9/B_{35}	A_1/B_{15}	A_9/B_{35}	A_9/B_{35}
A_{19}/B_{12}	A_{19}/B_7	A_{19}/B_7	A_{19}/B_{12}

Three days after Vandana was admitted to the special ward, that is, on 7th March, 1983, prophylactic antibiotics were started. Blood, urine, stools and sputum were examined repeatedly, to detect the presence of infection, if any.

9th March 1983. A small but very important operation was performed on Vandana. A thick, siliconised tube was put in the right atrium (upper heart chamber) through jugular veins. Henceforth, all the necessary nutrients would be put into the blood stream directly through that tube. A carefully prepared solution was used for that purpose, which contained meticulously calculated amounts of amino acids, carbohydrates, fats and fatty acids, minerals and vitamins.

12th and 13th March, very large doses of a very potent anti cancer drug—cyclophosphamide were given on those days to kill as many leukemic cell as possible.

15th to 20th March, 1983—Very high doses of whole body irradiation were administered to round off any leukemic cells lurking behind. The exact position of Vandana's body to receive maximum benefit from the irradiation was decided with the help of a dummy. The dummy was prepared well in advance, exactly matching Vandana's body shape and weight, and many trials taken to decide the final position. Special radio opaque shields were prepared to protect Vandana's lungs. Normally a radiation dose of 500-600 rads is fatal. Vandana, however, received 1200 rads altogether, distributed over six days. The aim was to make sure that even the last leukemic cell was killed. But such a high dose did not leave the normal tissues unscatched. Vandana developed large and painful ulcers on her lips and inside her oral cavity. She could not swallow any

A smiling Vandana with her father after the operation

food, not even water. Her hair fell off and her skin became pigmented. She developed fever that refused to come down even after extensive medication.

On 20th March 1983 the T-time, transplant-time had finally arrived. All the doctors involved had their hearts in their mouths. They were in a difficult dilemma—should they proceed with the experiment or give it up? Vandana was to receive her last dose of radiation on the 20th morning. But she was very very sick. She was hardly conscious. She was running very high temperature—the mercury in the thermometer quickly climbed to 108°F. May be the actual temperature was even more, since 108°F was the last mark. Could she tolerate the radiation session? What if she died in the process?

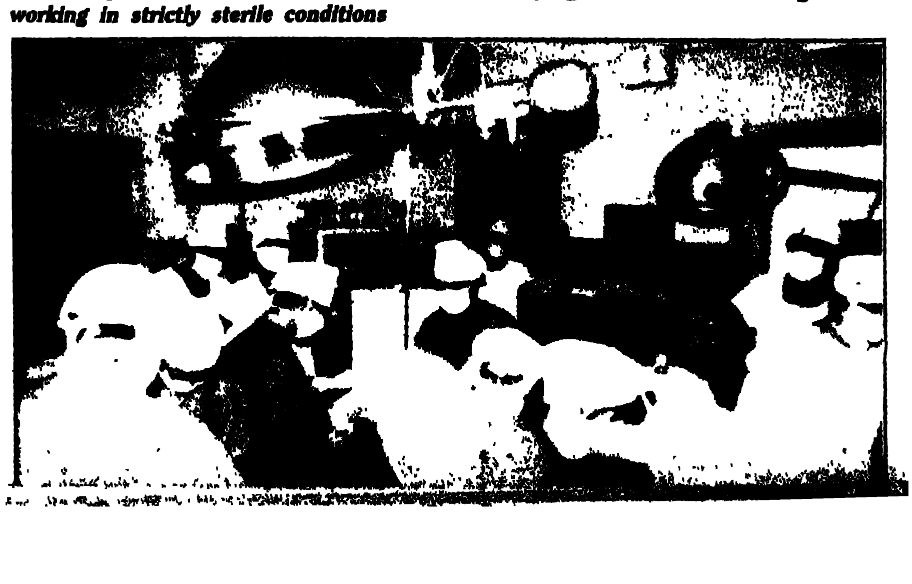
It was a very difficult choice exerting a tremendous responsibility on the doctors. Should they go ahead as planned? Should they wait for the temperature to come down? Should they cancel the whole thing—as the chances of success were very slim under such grim conditions?

The doctors made a brave choice and decided to go ahead. Vandana's father agreed—Vandana received her last dose. If death was facing either way, the doctors felt, why not give her a chance to live, however slender?

Umesh was taken in the operation theatre, anaesthetised, and his bone marrow was aspirated from his hip bone. About 300 cc of marrow was collected. At any one puncture site only 2-5 cc of marrow could be collected, as otherwise blood started seeping in and diluted the marrow. So his hip bone had to be punctured hundreds of times by a team of doctors to collect enough marrow. Of course, Umesh did not feel a thing, being under the influence of anaesthesia.

The marrow thus collected was then strained through a stainless steel mesh

The transplantation of Vandana's bone marrow in progress. Notice the large team working in strictly sterile conditions



to separate it from any bony spicules. The marrow, cleared of all contaminants, was promptly put in sterile plastic bags. The bags were immediately transported to Vandana's room and attached to a tube put inside her veins. Just like an ordinary blood transfusion, the marrow was run in her circulation.

The next twenty four hours were the most critical. If Umesh's marrow was to be rejected, a severe reaction would set in during that period. So a constant vigil was kept by Vandana's bedside. Her pulse, temperature, respiratory pattern every minute detail was watched and recorded thoroughly.

She could tide over the critical first postoperative day fairly well, but a new problem arose. She started running temperature. The fever was very erratic, had very high spikes and it refused to budge in spite of the latest, very costly antibiotics being flown in from abroad. All the tests carried out to detect presence of pathogens were negative—blood culture, urine culture, sputum culture failed to reveal the causative organisms.

Ultimately, antifungal agents were started on the off chance that she may have had a fungal infection in her blood. That therapy was started on the 11th postpoperative day. It produced prompt results and the temperature settled back to a normal level. So those medicines were continued for the next eight days.

Giving bone marrow cells just like a blood transfusion sounds funny, but it can be done because of an interesting characteristic of all bone marrow cells—they have a 'homing' mechanism. They have receptors on their cell surfaces. These receptors recognise the bone marrow cavity when the cells reach there. The cells then settle in and start multiplying and differentiating, producing the three different cell lines—WBCs, RBCs and platelets. Even one viable bone marrow cell may be enough to repopulate the whole marrow, but to ensure success, many cells are put in. The exact amount is calculated on the basis of the patient's body weight.

The tell-tale marks of a successful graft. Cells of Vandana's bone marrow show chromosomes now with characteristic male chromosomes (circled) derived from her brother's cell. This conclusively establishes the success of the operation

These processes of multiplication and differentiation take time. The patient's own marrow is already destroyed by the extensive chemo- and radiotherapy. So replacement is necessary from time to time. A cell separator is a specialised instrument that separates donor's blood into four components—serum, RBCs, WBCs and platelets. Any of these can be given to the patient as necessary.

The cell separator was kept running day and night to satisfy Vandana's needs. RBCs had to be given only thrice, but repeated platelet transfusions had to be given, as her own platelet counts remained dangerously low for forty-two days.

On the 17th postoperative day, Vandana started eating orally. The siliconised tube in her neck was removed.

Various tests were done to confirm success of the bone marrow transplant. Vandana's WBC count increased steadily and reached normal levels on the 21st postoperative day. Her bone marrow biopsy revealed all three cell lines—WBC, RBC and platelets growing normally.

One objection could still be raised. How could one know those were Umesh's cells? They could have been Vandana's own cells that had escaped destruction and had started growing again'.

Such an objection could easily be answered. The proof for success was very neat and noncontroversial—the sex chromosomes! Vandana's cells, being female cells, possessed 'XX' chromosomes. Umesh's cells, on the other hand, were 'XY'. Since only the marrow cells that were dividing and repopulating her marrow had come from Umesh's body, those cells and their progeny were showing XY chromosomes, whereas all the other cells in Vandana's body were showing 'XX' chromosomes. Presence of Y chromosome was a very convincing piece of evidence to prove that Umesh's cells had taken root in Vandana's body.

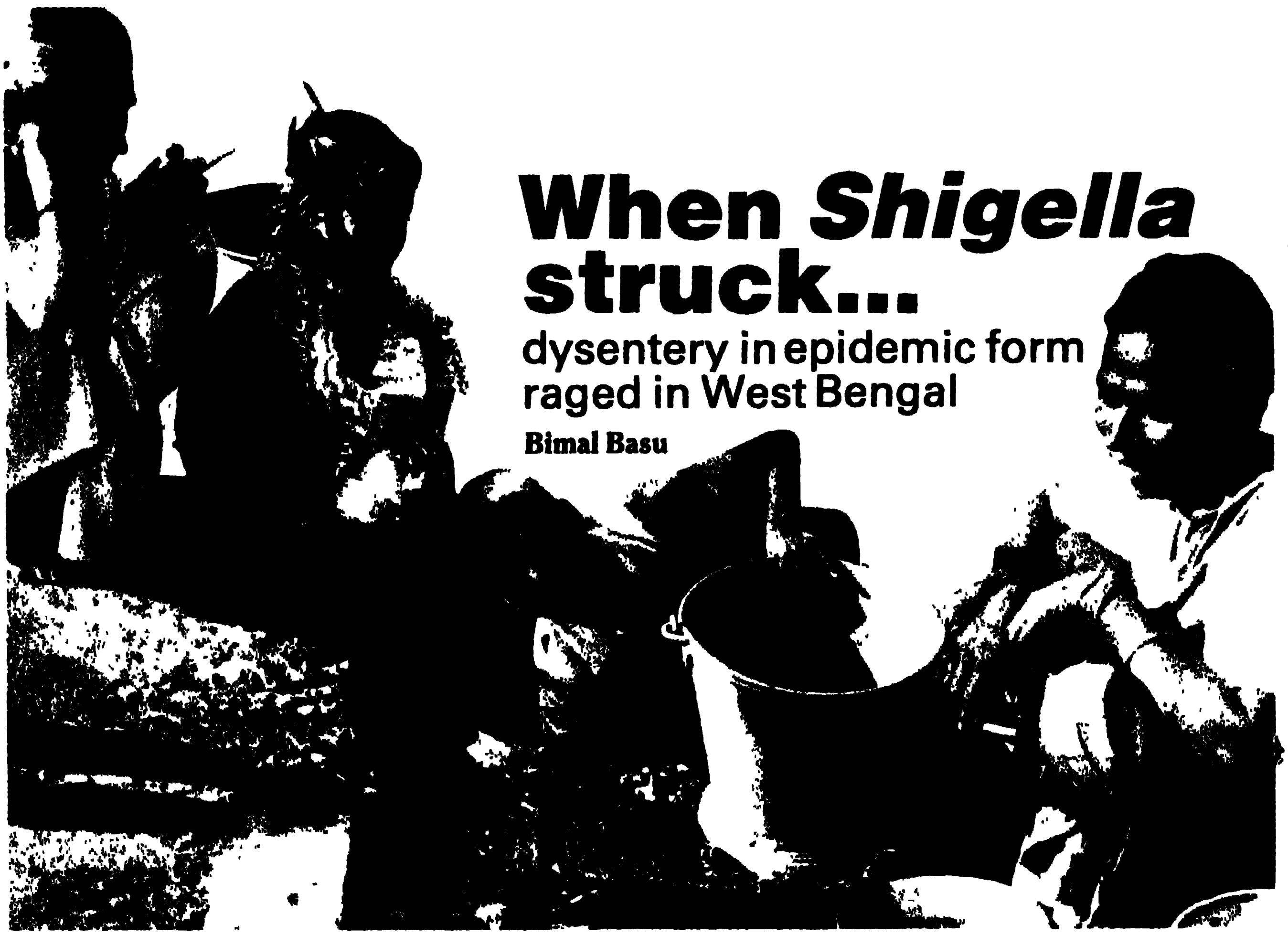
The whole success story, of course, had a price tag—a whopping Rs. 1,93,000/-. The very cost raises many relevant questions. Is it morally and ethically right to spend that kind of money for one procedure when even basic medical facilities are beyond the scope for most? Or is it another privilege that only the rich can enjoy? In short, can our country afford to do it again and again?

It will be wrong to jump to any conclusions or get scared by the massive figure. The first marrow transplant was so costly because it was the first. As the basic unit is set up and functioning on a regular basis, unnecessary precautions and duplications can be curtailed and time and money can be saved. Then the procedure will not remain more costly than the advanced surgeries being carried out on heart or brain in our country at many centres.

The most important argument in favour of a transplant is that it cures a disease that was hitherto uncurable—that too in children, who have all their lives ahead of them.

The first successful bone marrow transplant has shown very clearly that in our country, nothing is impossible when the latest knowledge, instruments, sheer determination and hard work come together. □

Dr Sowani is a practising consultant Physician at Pune. She had earlier received training in cancer chemotherapy at The Tata Memorial Hospital, Bombay and has conducted cancer research at the Institute of Medical Sciences, Tokyo, Japan



When *Shigella* struck...

dysentery in epidemic form raged in West Bengal

Bimal Basu

SHIGELLA has become almost a household name in West Bengal signifying panic. The dysentery caused by the bacterium of the genus *Shigella* affected nearly 80,000 people this year with death toll crossing 2,000, 80 per cent casualties being children. Wild rumours, ignorance and the furore in newspapers substantially further added to the panic. But strangely, these same factors spurred the administration into action, howsoever belated, and people who were generally averse to doctors and health centres, rushed to them at the slightest symptom of the disease.

It was around middle of March, 1984, that the dysentery epidemic struck West Bengal. Within two months all the 16 districts of the State came under its deadly spell. In West Bengal, extensive curative and preventive measures brought down the rate of incidence and death to a considerable extent. The epidemic started spreading to other states like Assam, Tripura, Orissa, UP, Bihar, Himachal Pradesh and Rajasthan in July 1984. Perhaps it may have turned into a national problem but for the timely rains.

Shigellosis - a global problem

Shigella bacillary dysentery or shigellosis has a global distribution with highest prevalence in countries where hygiene is poor. Of the various types of shigellosis, the infection due to *Shigella shigae* (Shi. dysenteriae 1) is the most virulent in character and often spreads in epidemic form. This type of infection has been uncommon in Europe and North America since 1920. But developing countries have a different story, with frequent epidemics claiming several thousands of lives and rendering a vast majority weak and helpless.

Shigella shigae or *Sh. dysenteriae* 1 was discovered by a Japanese scientist Dr. Shiga in 1896 and was named after him. There are 34 serotypes of *Shigella*, intimately related micro organisms distinguished only by their antigenic composition. The first member *Sh. dysenteriae* 1 produces the most severe disease with various complications. On the basis of biochemical and serological reactions, the genus *Shigella* is commonly divided into four species: *Sh. dysenteriae, Sh. flexneri, Sh. boydii* and *Sh. sonnei*. There are 10 serotypes of *Sh. dysenteriae*, eight of *Sh. flexneri* and 15 of *Sh. boydii*. The varied serotypes of the *Shigella* bacterium should give us some idea of the complexity of the disease, especially in its wide spectrum of symptoms and the line of treatment to be followed.

The most common symptoms are frequent passage of stools with blood and mucus, abdominal cramps, painful and ineffectual straining to relieve the bowels (tenesmus) and fever. Persons affected with *Sh. dysenteriae* 1 may pass any number of stools from 10 to 70 per day. Visualisation of the interior of large intestine with an endoscope reveals a diffuse inflammation of lining of colon, mostly confined to the rectum and sigmoid colon and sometimes extending as far as the caecum in the

The author writes about the recent West Bengal epidemic on the basis of field visits and talks with several government and health officials

abdominal cavity. Ulceration and perforation of the intestinal wall with bleeding may also occur, and patients often die of septicaemic shock or blood poisoning, when the infection is disseminated in the body through the bloodstream.

Studies show that virulence of *Shigella dysenteriae* 1 lies in the three kinds of toxins liberated by it. Of these, the cytotoxin is responsible for inflammation and ulceration in the large intestine and enterotoxin causes watery diarrhoea, which, according to some experts, has been misunderstood as common gastroenteritis in the present epidemic in West Bengal. The third kind of shigae toxin, the neurotoxin, may give rise to several complications like paralysis, seizures, leukemoid reactions, septicaemia and pulmonary involvement.

Man is both the reservoir and natural host of all types of *Shigella*. Infection is by the faecal-oral route, from hand to mouth—water taps, door-handles, lavatory seats often act as transmitting agents. It also spreads through contaminated food or drink and water, though *Shigella* bacilli are not essentially water-borne. Where excreta disposal facilities are inadequate, particularly in rural areas, flies may be an important vector in the transmission of shigellosis. But the most common mode of spread is by person-to-person transmission.

It has been established by both laboratory and clinical studies that *Shigella dysenteriae* 1 has multiple drug resistance. It responds to few specific drugs like furazolidone, neomycin, gentamycin and nalidixic acid. Doctors handling large number of patients in different parts of West Bengal have also been facing the problem of drug resistance.

West Bengal scene

At the request of the Department of Health, Govt. of West Bengal, a team of scientists from the National Institute of Cholera and Enteric Diseases, I.C.M.R., Calcutta, carried out an investigation on the outbreak of acute diarrhoeal diseases in a village in Hooghly district, 72 kms from Calcutta. *Sh. dysenteriae*, type 1 in six cases and type 2 in one case was isolated from 22 samples collected from 91 affected persons. The percentage of *Shigella* isolation was 31.8. As *Shigella* type 1 is known to spread like wildfire, the Health Department was immediately alerted by the Institute to take quick measures against the disease. Since early April, this unusual type of dysentery began to spread from village to village, from district to district, truly like wildfire, which is a typical characteristic of *Shigella dysenteriae* 1. Urban and municipal areas were also not spared.

According to an expert from the All India Institute of Hygiene and Public Health, Calcutta, the start of the epidemic may be traced back to October 1983, when a village named Kaladanga in the Murshidabad district of West Bengal, was struck by a virulent type of dysentery affecting 45 persons and causing seven deaths. The incidence has been gradually increasing since then. A number of experts and doctors believed that most of the cases were due to chronic amoebiasis, giardiasis, worm infection, gastroenteritis, and even cholera, which has been plaguing this state for centuries. In fact, cholera is a regular pre-monsoon feature. They say that this year, a severe type of shigellosis has been added to this age-old malady, but its occurrence is not more than 10 per cent.

Lack of potable water forced people to tap any water source

A 10 per cent isolation of *Shigella dysenteriae* 1 was obtained by the School of Tropical Medicine, Calcutta, which is a state govt. research institution. On the other hand, tests undertaken in the prestigious National Institute of Cholera and Enteric Diseases, Calcutta, where the most modern techniques of identification are being applied, revealed 32 per cent isolation of *Shigella dysenteriae* type 1. Out of 447 stool samples examined from different hospitals in and around Calcutta, *Shigella dysenteriae* type 1 was found in 158 (35.3 per cent) and all species of *Shigella* from 52.3 per cent. A team from Nilratan Sarkar College and Hospital obtained 25 per cent isolation of *Shigella* type 1 in stool samples collected from the most affected Coochbehar district of northern West Bengal. According to the eminent microbiologist Dr. S. C. Pal, Director, National Institute of Cholera and Enteric Diseases, Calcutta, the picture would be more or less the same in other affected districts also. Moreover, the rapidity and mode of spread of the epidemic, the specific symptoms in large number of patients, clearly indicate *Shigella dysenteriae* 1 as the chief causative agent, which is new to West Bengal. The cases where watery diarrhoea or even gastroenteritis were found, may also be due to shigellosis, which often starts with watery diarrhoea.

Sources of infection

How the infection of *Shigella* bacilli started in West Bengal is not definitely known. One of the chief causes may be scarcity of potable water in rural areas.

G JOARDAR

Drought at the beginning of summer and over-use of tubewells for irrigation resulting in the lowering of water table and compelling people in many villages to drink unsafe pond-water might have resulted in spread of infection. Interestingly, water samples collected from different affected areas did not show presence of any *Shigella* pathogen on laboratory tests.

The second transmitting agent is undoubtedly flies. In almost all villages in West Bengal there is no excreta disposal system and people defaecate in open fields and flies are in abundance. While visiting several affected villages in Murshidabad district, flies moving like shuttlecocks between fresh excreta of diseased children and uncovered food materials could be seen in a number of houses.

Malnutrition, especially in children makes the poor more susceptible to such diseases and ultimately death. In West Bengal, mostly children below 10 years of age but above six months have died due to this epidemic. But those below six months have been rarely affected as they are mostly breast-fed and thus adequately immune to several diseases. However, well nourished children or adults are equally attacked by shigellosis. Mere nourishment cannot prevent the disease, but only smothers it.

The fourth and probably the most prominent cause behind the epidemic is complete lack of sanitation and personal hygiene, which stems from absence of health education. A doctor of Berhampore, Murshidabad, narrated how one of the patients swallowed a few halogen tablets thinking that these would work as a vaccine against dysentery. Another young doctor from a Primary Health Centre expressed his harrowing experience of a village woman who used the same piece of cloth to clean both the anus and face of her diseased child. And the doctor failed to convince her how dangerous this practice was. Under such conditions, person-to-person transmission of the disease through food or water chain is highly probable and that is what has actually happened in West Bengal. The epidemic has spread in jumps, from one house or village to another, leaving a few neighbouring houses or villages completely untouched.

Work on war footing

At the onset of the epidemic the state government officials, health authorities and field workers were utterly baffled and unprepared. But soon preventive and curative measures were adopted on a war footing. Millions of halogen tablets, though far below the actual need, were distributed in affected areas. Shallow tubewells, especially those with no cement platforms and open wells were disinfected by adding bleaching powder. Para-medical staff, *panchayet* members and workers of a number of voluntary organisations started campaigning for do's and don'ts like: (1) drinking boiled or halogenated water, (2) covering faeces with soil, (3) covering food to protect it from flies, (4) avoiding the consumption of exposed raw vegetables and cut fruits, (5) washing the hands and mouth with soap before eating, and (6) using sufficient water for domestic work, as the disease is said to be "water-washed".

As for curative measures, the government of West Bengal had already spent about three crores of rupees. Primary and subsidiary health centres, normally suffering from a dearth of drugs, were flooded with both conventional and sophisticated drugs. Paramedical staff was employed for door to-door treatment and for distribution of drugs in remote areas. Doctors and nurses worked round the clock with full dedication; voluntary organisations like Health Service Association and Junior Doctors' Council sent medical teams to the remotest parts of the worst affected districts, where thousands of patients were treated in temporary camps.

Generally a five-phase therapy was adopted for treatment. The first two phases consisted of using conventional diarrhoeal drugs and antibiotics of tetracycline group. 80 per cent of the cases responded to this treatment. On non-response, the patients were hospitalised and kept on a furazolidone suspension. When this also failed, gentamycin or nalidixic acid tablets were given. A few patients died even after that, maybe due to complete dehydration or some undiagnosed complications.

However, it is most unlikely that such systematic therapy was undertaken in every affected area. The reports have been otherwise. In most areas drugs have been used according to supply and availability and not according to the needs ascertained by proper pathology tests. No specific directions of treatment were issued to the operating medical staff. A full course of treatment could not be given to the majority of the affected population. As a result, they developed drug resistance, aggravating the situation still further.

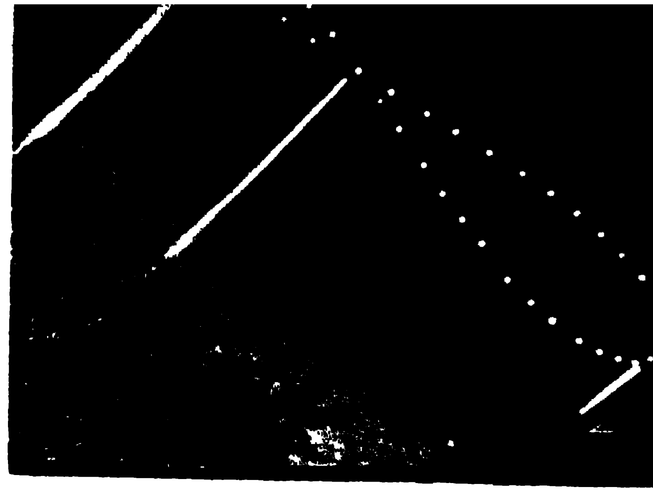
Points to ponder

This is not the first time that severe diarrhoeal diseases have occurred in West Bengal. May be *Shigella dysenteriae* has made its first appearance in the state, but that does not minimise the previous record. According to a *Bulletin* of the Junior Doctors' Council, Calcutta, diarrhoeal diseases took 76,874 lives from 1970 to 1976 in West Bengal. In 1971 alone the death toll was 19,184. In fact, the maximum death rate (3.6%) due to this year's epidemic is much below the state's average rate of death (5.75%) from such diseases. Somehow the state government rose to the occasion this time.

But the point is not to contain the present epidemic and heave a sigh of relief. Control and preventive measures must be a sustained process. To wait for a disease and then to cure it is a negative approach, affecting the gamut of our health programmes. Unless a positive and a scientific master plan for prevention of diseases and health education of the masses is adopted "Health for all by 2000 AD" will remain a utopian dream before us. □

Mr. Basu is a science writer and journalist attached to Ananda Bazar Patrika, Calcutta

HERE is a book to definitely expand your mind: a collection of one hundred historic scientific photographs accompanied by lucid summaries giving details, background and anecdotes associated with each image. Each is unique in some sense, some photographs are classics like Rontgene's radiogram of his wife's hand or the discovery of Pluto plates. Others, like the photographs which launched aerial archaeology, are less well known. There are curiosities like Murray's first unbroken filmstrip which catches a falling cat in full



Multiple exposures showing the Sun's annual path which has the shape of an analemma **(top). Seen at left** *is life before birth.* **Above right** *is a false colour microwave image of the Antarctic winter. The ultraviolet veils of Venus are seen at* **bottom left**

somersault An unknown photographer has caught the last gape of the Tasmanian Tiger (which is now believed to be extinct).

Beyond Vision is more than a catchy title [our own cover story (December 1983) on the subject was "Beyond the limits of the human eye"] It nicely defines what is meant by a scientific photograph, "namely one which provides information inaccessible to the human eye On all scales, from the submicroscopic to the cosmic, photography has the ability to expand our vision, to reveal invisible radiation, to capture fleeting events, to freeze vanishingly faint images, to reach remote regions of space and ocean which the naked eye cannot capture" Francis Thompson could be describing scientific photography when he wrote, "O world invisible, we view thee O world unknowable, we know thee Inapprehensible, we clutch thee " This superbly designed and lavishly produced book also contains a concise history of scientific photography ☐

"Beyond Vision" by Jon Darius, Oxford University Press, £ 15

DR. BHIDE, POONA VARSITY VC

DR. VISHNU GANESH BHIDE, Professor and Chairman, School of Energy Studies and Materials Science, Poona University, Pune, is appointed vice-chancellor of the university with effect from 23rd August

Dr. Bhide, a renowned physicist, has made valuable contributions to several branches of solid state physics such as Mössbauer and X-ray spectroscopy, ferroelectrics and liquid crystals

The field of Mossbauer spectroscopy is his speciality He showed experimentally, for the first time, the existence of the soft mode and its temperature dependence in ferroelectrics His studies on the after effects of decay of Mösebauer sources in various lattices brought out the existence and life times of non-equilibrium charge states

His research in the field of ferroelectrics includes a suggestion of a new method to picture its domain walls He has also studied the domain dynamics in ferroelectrics and ferromagnetics.

He pioneered research and development in solar energy. He gave a new concept of structured selective coatings for solar energy applications.

A fellow of Royal Astronomical Society, Indian National Science Academy, Indian Academy of Sciences, Dr Bhide, is a member of the International Commission on the Application of the Mossbauer Effect He is also the director of the International Solar Energy Society.

Dr. S. Varadarajan, Director General, CSIR

DR S. VARADARAJAN has taken over as the Director General of Council of Scientific and Industrial Research (CSIR) and Secretary to the Government of India, Department of Science and Technology (DST), for CSIR affairs Until now he was secretary at DST

Associated with CSIR for a long time, Dr. Varadarajan, was on its scientific committees and the executive committee of the

Central Food Technology Research Institute, Mysore, since 1964 He was the chairman of the Research Advisory Council of the National Chemical Laboratory, Pune He has been a member of the editorial boards of *Indian Journal of Chemistry, Research and Industry* and other CSIR journals

Fellow, Royal Institute of Chemistry, Dr Varadarajan is distinguished for his original contribution in the determination of nucleic acids through X-ray crystallography His research work also includes the fields of chemistry of natural products, synthesis and structure of RNA and DNA and their functions

Appleton Prize-1984

THE Appleton Prize for Ionospheric Physics for 1984 has been awarded to Professor K D Cole of La Trobe University, Melbourne, Australia, in recognition of his distinguished contributions to understanding the fundamental process taking place in the magnetosphere and ionosphere.

Professor Cole has played a leading role in the Scientific Committee for Solar Terrestrial Physics, of which he has been President since 1977.

BRAIN TEASER

ISLAND OF QUESTIONERS

THE island of questioners derives its name from the fact that the inhabitants never make any statements, they only ask questions The questions are answerable by only an yes or no.

Each inhabitant is one of the two types Y or N. The Y-type ask only those questions whose correct answer is 'yes', those of type N ask questions whose correct answer is 'no'

I once visited this island and met a couple named Suresh and Sumitra. I heard Suresh ask someone "Are Sumitra and I both type N"?

What type is Sumitra?

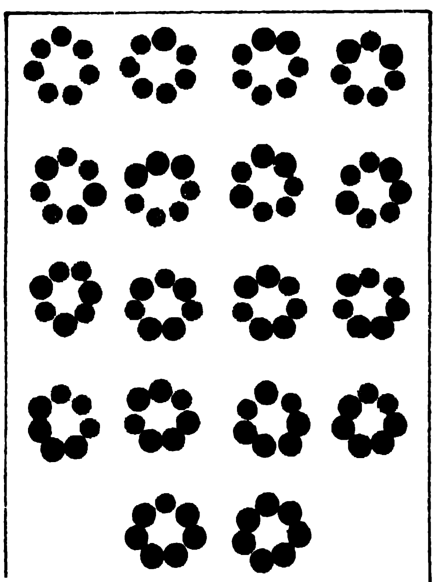
(Solution next month)

S. G. Deshmukh

An exceptionally large number of readers have sent in the correct solution to our July teaser. We congratulate each one of them and regret that we are unable to ... their names.

Solution to August teaser

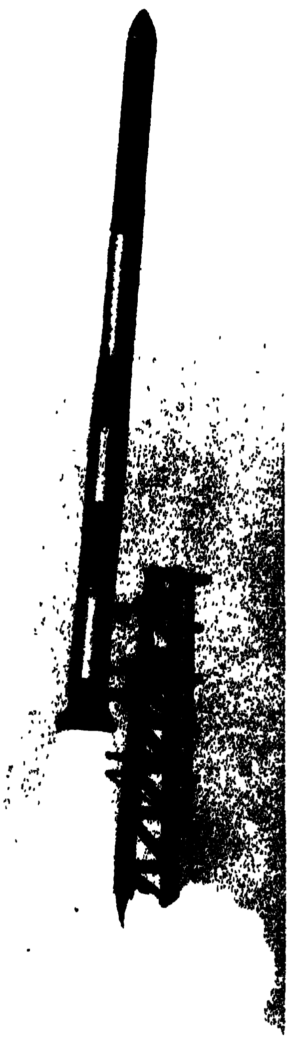
Necklaces



There are 18 different neckla ces, as shown in the figure. Sixty-three beads of each colour (we have used green colour instead of red) will be required.

A LETTER TO A YOUNG SCIENTIST

Yash Pal



17 DEFENCE COLONY
ALTO PORVORIM
GOA - 403521
4th June '84

Dear Prof Yashpal,

There are a few questions which arose in me during Sqn. Ldr Sharma's historic space flight with his soviet colleagues. I would be much obliged if you could give me their answer -

① In an environment of micro-gravity or zero-gravity -

a) A bottle is half filled with water. This bottle is closed and then fixed on a firm base where would the water be situated in the bottle?

b) A bottle is half filled with water. This bottle is kept open and is fixed on a firm base, will the water remain in the bottle or will it come out through the mouth?

c) Water is spilled in about 3 different places, this water will rise in the form of globules but will these globules get attracted to one-another to form one big mass of floating water?

② In space can blood-transfusion or glucose drip be administered to a person? If so how?

③ It is said that when man goes up into space he increases in height for that period of time and returns to his original height once he is back on earth. why does this happen what is the factor affecting this sudden growth? It is also said that sometimes the cosmonauts spine develops problems in later years due to this sudden increase in height but wouldn't the whole bone structure get affected after all we grow as our bones grow?

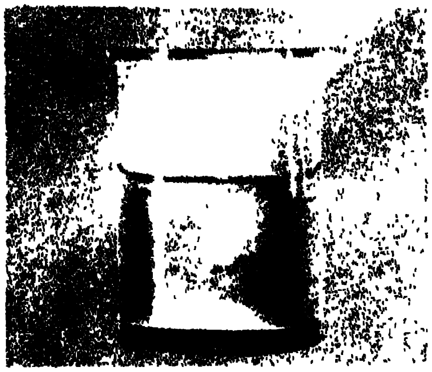
I am 15 yrs of age and am a great admirer of our two cosmonauts. It was a real treat to have them in Goa. even if it was for just a day. I had attended the press conference held here and got their autographs It was just great for me! I have made a scrap book on the space mission and am quite proud of it even though it isn't up to much!

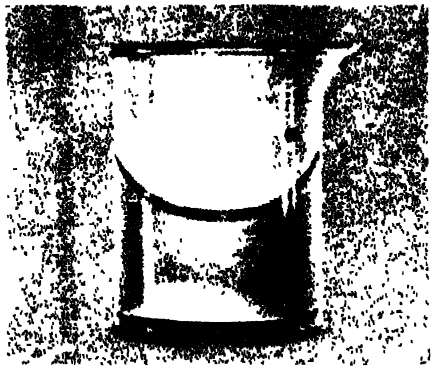
I shall end now and I hope it isn't too much of a bother. I will be waiting for your answer.

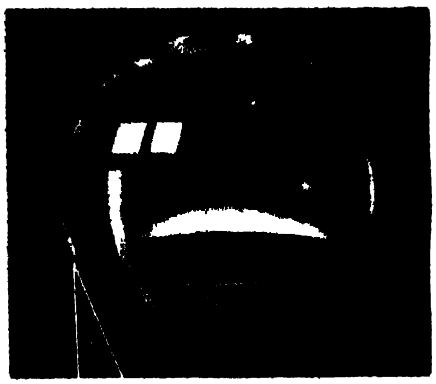
Yrs sincerely
Anjali Barretto.

ILLUSTRATIONS BY SHETF NASHEB

Prof. Yash Pal, who is Chief Consultant to the Planning Commission, writes to a young girl about the marvels of micro-gravity







Beakers of water (top) on Earth and in space. Above:
Bulbs with liquids and respective vapours. Notice varying angles of contact. (a) Too little liquid forms a semilunar bottom layer. (b) Excess liquid forms a top vapour sphere. (c) Liquids with a small angle of contact result in an island of vapour in liquid. In non-wetting liquids (α=180) like mercury, we have exactly the reverse conditions

ILLUSTRATIONS BY SHETE BHUWASHEB

My dear Anjali,

SOME of the questions you have asked, and many others, can be answered if you realise that in micro-gravity condition, the effect of surface or contact forces becomes dominant. For example a blob of water would float as a sphere, no matter whether large or small. However, if you placed it at the bottom of a beaker, the shape of the surface would depend on the surface interactions (or forces) between water, glass and water vapour. This is usually quantified in terms of giving an angle of contact between glass and water surfaces.

This interaction is responsible for the fact that water seems to want to rise a little near the walls of the beaker. This surface force is also responsible for the phenomenon of capillarity. For water and glass, the angle of contact is less than 90°. For mercury and glass, on the other hand, it is more than 90°. This is the reason that water surface is concave near the glass surface, while the mercury surface is convex. Same physics is responsible for the fact that water wets glass, while mercury does not wet glass.

Coming back to your question, in micro-gravity the shape of the surface of water placed in a beaker would be curved all over and not only near the edges because of the absence of hydro-static pressure in micro-gravity (see left).

So the picture would look as at left:

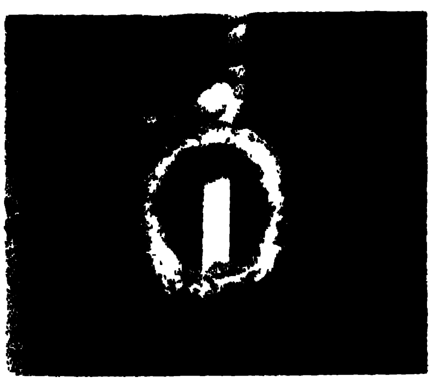
Therefore it does not matter whether the beaker (or bottle) is closed or open. One is assuming that the atmospheric pressure is normal. Because in a vacuum the water will boil even at a low temperature.

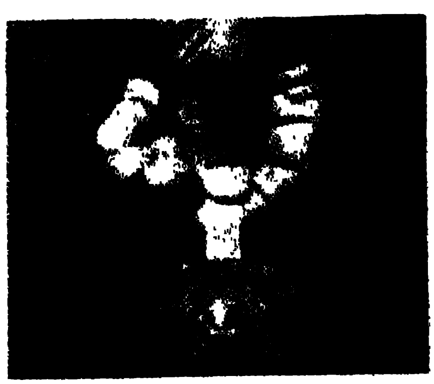
I have come across some illustrations which you may find useful. These indicate the disposition of liquid and vapour in a spherical bulb, under conditions of micro-gravity.

You would notice that spherical surfaces are preferred. This is because the force of surface tension on the liquid vapour interface causes a liquid sample to assume the smallest possible size, which is a sphere; in other words, the ratio of surface area to volume is minimum for a spherical shape.

Thus if some blobs of water are brought in contact, they would coalesce to form a single spherical blob (provided of course they are free and other material surfaces are not involved).

You might be interested in another





A bar of icecream (top) just melts down into a puddle on Earth. In space, however, it behaves oddly. It too melts, but under micro-gravity, instead of a puddle the liquid coalesces into a hollow ring and eventually you get a spherical lump at the end of the stick

interesting example. If I hang an ice-cream stick in a space ship, it will of course melt, because of conduction and radiation of heat from the surrounding. Convection will be absent because of zero gravity. So the melting would proceed as shown at left

As you know here, on earth, at normal gravity conduction, radiation, and (most important) convection lead to melting, and the melted portion keeps dripping on the ground and on your clothes

Your question about blood-transfusion, or the drip has an obvious answer. You must provide a force other than gravity for the liquid to flow You could have a syringe, which is driven by gas pressure, for example Or a small pump. The need to pump fluids in space is encountered in many different ways. For example, pumping of fuel and oxidizer for the rocket engines is done with gas pressure and/or turbo-pumps. Even on earth you don't depend only on gravity to ensure movement of fluids. Indeed you often pump against the forces of gravity and friction.

Your last question is about the temporary increase in height of astronauts, or cosmonauts (if they ply on Russian space craft). You perhaps know that there are disc like structures between vertebrae. These are compressed on earth because of body weight, and weight of things we wear and carry. In micro-gravity there is no weight and these intervertebral discs stretch a bit, leading to increase in height However, when the cosmonauts come back to normal gravity, they slowly compress back again, and the person comes back to original height.

There are many other physiological changes which occur in space, and not everything is fully understood Some atrophy (wasting away) of skeleton and muscles occurs Bones are demineralised and there is a loss of calcium. Other changes happen, in different degrees, in all organs and functions of the body, though some of these can be reduced through proper exercise. Study of space physiology and space medicine is important for understanding many things that happen, and perhaps also to gain better insight into processes, which occur even under normal gravity.

(I hope I have been able to answer your questions to some degree.)

Yours truly
Yash Pal

SOLAR DRIERS

Continued from page 28

and the heated air passes through the produce to be dried which is stacked at another level; a chimney is used with this drier to augment the air flow rate. Such driers have been designed and tested in other countries too, including the Asian Institute of Technology, Bangkok. Efforts are continuing at various institutions to use alternative materials such as plastics for design and fabrication of natural convection driers.

For drying grains such as paddy, maize and oilseeds, forced convection driers are used. Much work on this is being done in India, particularly at Annamalai University, and IIT, Kharagpur, and several demonstration systems have been installed. In the last five years, work has also been initiated on crop drying systems at many other institutions—the Central Arid Zone Research Institute, Jodhpur, PAU Ludhiana, Central Rice Research Institute, Cuttack, Tamil Nadu Agricultural University, Coimbatore, M.L.S. Univeristy, Udaipur, IIT Delhi, Central Building Research Institute, Roorkee, Agricultural University, Pant Nagar, and many others.

In many forced flow solar driers, an array of solar absorbers forms the roof under which the motor blower set and the drying chamber are installed. Such solar driers have been built at Annamalai University, IIT, Kharagpur, etc; the one-ton-per-day solar paddy drier built at Annamalai University in 1976 has a roof-cum-solar flat-plate collector with a gross collector area of 50.75 square metres. The sloping asbestos roof of the Amul Dairy milk plant at Anand, Gujarat, has been converted as a solar air heater to act as a pre-heater for spray-drying of milk

One of the large solar driers is the 10-ton per-day drier installed at the State Farm, Ladowal, near Ludhiana, by the National Industrial Development Corporation (NIDC). The size of the single glass absorber is 160 sq m at an optimum angle of 45° with the horizontal. The NIDC has also used solar energy, with a supplementary heat source, to cure tobacco at Rajahmundry in Andhra Pradesh. Solar energy meets the major heat requirement up to 50°C to 55°C during day; the supplementary heat source meets any shortfalls.

Seasoning of wood in solar kilns has been studied at the Forest Research Institute Dehra Dun, Central Building Research Institute, Roorkee, and at many other places including Maharashtra and Punjab. The initial capital and operating costs of solar kilns have been found to be lower than those of conventional steam-heated kilns.

Studies are also being carried out at many institutions to determine the technical and economic feasibility of drying various other crops with solar energy.

Solar driers are likely to be used first for drying crops, such as tobacco, cardamom and tea leaves, which are already being dried with conventional fuels. It is here that solar crop driers can prove their usefulness in reducing fossil fuel consumption.

For crops such as paddy and maize, solar driers, though they give a better product, are more expensive to be used by an individual farmer. Therefore, work should be undertaken to study the economic viability of using large-scale solar crop driers for use by agencies handling and storing large quantities of foodgrains.

Studies should also be carried out to use alternative material such as black and transparent polyethylene sheets to make solar air heaters. All-plastic/polyethylene solar air heaters have been used in other countries for drying purposes. They have an added advantage of being portable.

As far as drying of vegetables and fruits is concerned, natural convection driers, especially the multi-rack type, are quite efficient and hygienic. The economics of these dryers is fairly independent of the size. □

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VARIOUS factors influence the drying process in a solar drier—the relative humidity of the air, air temperatures, air flow rate, initial moisture content of the produce and the final desired moisture content of the produce. The most important of these is the relative humidity of the drying air.

In the initial stage of drying, the moisture removal rate (mainly from the surface of the grain) is high. When the surface moisture has been removed, further drying depends upon the rate at which the moisture from within the product moves to the outer surface. At this stage, the increase in the temperature of the drying air rather than an increase in flow rate improves drying.

The performance of solar air heaters is evaluated in terms of solar energy collection efficiency and pressure loss coefficient. The solar energy collection efficiency refers to the ratio of useful energy collected (heat utilised in heating air) to the solar energy falling on the collector in a given interval of time. The pressure loss coefficient is a measure of mechanical power required to pump the air through the absorber. The pressure loss coefficient refers to the ratio of pressure drop in the air heater to the dynamic pressure in the air heater.

COOKING BY THE SUN

Continued from page 26

Rs. 150 to Rs. 300 for a box type cooker. Despite these subsidies and despite public and media demonstrations of the cookers, they are not being sold. Only about 30,000 solar cookers have been sold in the last three years against a target of 50,000 in a country where about 100 million families live.

Obviously, something is lacking in our efforts to introduce solar cookers. The Government should reexamine the whole issue of introducing solar cookers for if we fail now we may become a laughing stock again. Efforts to popularise the focusing paraboloid cooker in the fifties had failed.

The failure may be due to a variety of technical, economic and social reasons. There are several problems with the present box type cookers: the black paint chips off, the window glass, the glass reflector, the wooden frame, hinges and castor wheels break, moisture condenses within the two glasses and much heat is lost. More research and development is needed if we are to develop a solar cooker that will be accepted by the people. But the fact is, nobody is seriously working on modifying the cookers. A few institutions are, of course, trying to introduce them in rural areas just to show the progress of the institutions. □

Laughter unmasked

Student: Dostoyevsky's in his novel A Raw Youth, *says, "Gaiety is the most distinguishing feature of man... You may not be able to understand the nature of another person for a long time, but if the man laughs genuinely at some point, his entire being is suddenly revealed... If you want to scrutinize a person and know the depths of his soul, then study him not when he is silent, or when he speaks, or when he cries or even when he is excited about a noble idea, but look into his heart when he laughs. If he has a good laugh, that means he is a good man. Laughter is the most accurate mirror of the soul." What do you think of this conclusion? Dostoyevsky is considered a great expert of the human psyche but is laughter really the most accurate mirror of the soul?*

Professor: I would have to agree with Dostoyevsky. No two people laugh in exactly the same way. A diagnosis of a person's individuality on the basis of studying his laughter can be highly accurate.

S: Do you mean to say that a person's laughter is like his fingerprints?

P. I wouldn't put the two on the same level.

S: Then could you please explain exactly what laughter is?

P. All right. (Smiling.) Have you read John Keats?

S. Yes. He was an English romantic poet at the beginning of the 19th century.

P: Then you probably remember that the rainbow was one of his favourite images in his early poems, though in his later works there is no mention of it anywhere. It is said that once Keats read Newton's explanation of a rainbow from the point of view of physics and after that seeing a rainbow no longer delighted him as much. Aren't you afraid of losing your laughter if you learn what it is from a physiological point of view?

(Laughter from the postgraduate student).

P. You have reassured me. Physiology, psychology and neuropathology define laughter as the manifestation of a particular class of positive emotions. Man inherited the mechanism of emotions from his animal predecessors. On the basis of emotions, in conjunction with the interaction of the intellect, feeling developed, though it is sometimes difficult to distinguish between emotions and feelings. The term "emotional state" refers equally to emotions and feelings.

Any information perceived by our sense organs is initially evaluated emotionally (or instinctively), not rationally: pleasant-unpleasant, necessary-unnecessary, dangerous-safe. Nature made sure that our organism reacts to a phenomenon before it is assimilated and analysed.

In this way, we pull our hand away from a hot tea kettle before we consciously think about the fact that we will be burned if we did not. Or, for example, at this very moment I see by your face that you are dissatisfied with my explanation since it is emotionally perceived by you as not having any relation to laughter. Am I right?

(Postgraduate student smiles sheepishly.)

P: But emotion even anticipates an event, and in fact, does this very distinctively: the more doubtful the anticipated result, the happier the reaction when a person learns that the goal is near.

S: But it seems to me that not every positive emotion, even the greatest joy, causes us to laugh.

P: You are right. Laughter arises only when one of several specific circumstances occurs simultaneously. I can name four

The first we call *"false prediction"*. A person laughs if the information received exceeds, and at the same time depreciates the anticipated result. That is if he suddenly realies that what he expected only seemed true and significant. We can use a joke as an example:

"Waiter, there is a fly in my beer!"

"Don't worry. The flies here don't drink much."

After hearing that simple joke, one person will laugh heartily, while another will only grin. Why? The first man was the most mistaken in a prediction. Obliging listeners such as these are usually unsophisticated, naive people who are easily fooled. The more deeply the person was sure of the truth of the prediction and the more clearly that error is brought to light, the stronger the release of positive emotions and the stronger the laughter.

The second is *"black and white"*. A person laughs if the difference is what he anticipated and the subsequent information received is immediately perceived, without any agonising thinking or lengthy comparisons. A talented comedian tells jokes fast, not relying on his listeners' analytical powers but on their emotional orientation. Here a fraction of a second is enough. Laughter arises involuntary, intuitively, and is immediately followed by an outburst.

The third is called *"watching from the side"*. Laughter arises on the basis of

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Close encounters of the fourth kind

Arun Sadhu

General Vishwajit Fernandes was angry Sixty eight was no age to feel tired—not after a mere morning walk in the forest, the brisk jaunt he had grown used to for the last 11 years since his retirement from the army He had come to live in that bungalow And be it sun or rain General Fernandes never missed his heady walk With a beret and a blazer, casual shoes, a walking stick and a revolver he would be off on his "constitutional' an hour before sunrise He would return two hours later after covering fifteen kilometres to a hearty breakfast

Today General Fernandes felt out of breath and confused. "Have I lost my way or my mind," he thought irritably The sun-rays slanting through the foliage indicated that he was rather late in returning home How could he possibly have lost his way? He knew the jungle like the back of his hand, at least that part of the forest near his bungalow Every tree, the shapes and the hollows of the trunks, the dense canopy of the foliage, the little rocks and rivulets, the slopes and the narrow jungle pathways, and, above all, that oval meadow in the middle of the forest. Oh yes, today he could not even reach to the edge of that natural lawn Not that he went there every morning But he loved the sense of heavenly tranquillity it offered, the virgin grass untouched by coarse human feet, the chital and hares browsing on the grass under the morning sun It was a superbly secluded place unknown to most people General Fernandes had known of it from army files The forest had been cleared several decades ago here for a prisoner of war camp After the war the camp had been dismantled But the clearing remained like a light emerald in the middle of the dark green forest

General Fernandes abruptly found himself out of the woods He was startled.

"Oh damnation!" he muttered "Am I getting on to dotage?" He gave a barking laugh and turned to look at the forest quizzically "Ah, no," he decided, "I am

neither old nor senile. Something's wrong, definitely..." He tapped his head and walked briskly home.

The Gurkha soldier guarding the gate of his bungalow saluted smartly and the General suddenly realised that he was late by nearly half an hour for this morning's appointment with a young man. He frowned.

"Good morning darling, are you all right?" his wife greeted him in the porch with a trace of concern in her voice.

"Oh, oh... Good morning Pamy..." General Fernandes looked flustered. "Tell me Pamy, do you think I am old and senile?" he asked.

Pamela Fernandes was not surprised though her husband asked this question for the first time in their married life. She was well-preserved at sixty, with only the cropped grey hair betraying the years. Already, the first cigarette of the day dangled from her lips.

"So you do realise this today, Vish," she said gravely. Fernandes laughed and turned to go to his bedroom to change. Pamela blew out a cloud of smoke and said, "You are late for breakfast... I was worried,at your age, Vish...".

"I was thoroughly foxed in the jungle today. Nearly lost my way... Has that young man turned up? Come darling, why don't you join us for breakfast for a change...?".

Breakfast was laid on the lawn. The dazzling white cane chairs and table set against the green grass, birds twittering in the trees, the nip in the air and the golden slanting sun rays lent an intoxicating touch to the scene. A young man of hardly 19 years sat in a chair engrossed in newspapers. He was Parikshit Bhasme, a doctoral student. Fernandes made it a point to look up his name in the visitor's book.

"Good morning young man."

"Good morning sir."

Parikshit rose to submit his slender hand into the grizzled paw of the General. Fernandes shook it carefully. Parikshit was boyish, slightly built with a hint of a moustache and a pale complexion; all this made him look even younger than his years. But the redeeming feature of his personality were his large, brilliant eyes, General Fernandes was taken aback by their penetrating luminosity. He was impressed.

"Sit down my boy, relax," Fernandes said removing the newspapers from the table. "And what tidings of disaster these papers have brought us on this very fine morning?"

"Nothing unusual," Parikshit smiled wryly, "except that we are a few moments nearer to nuclear doom."

Fernandes picked up a newspaper and looked the front page.

"My God... stupid... idiots...," he exploded. "They are insane..."

He read a couple of columns carefully and suddenly threw away the paper sighing. "You know, my boy... Ah, well, Parikshit... How stupid and senseless we human beings are. You see, this new missile developed by the Americans... it costs as much as one hundred medical colleges. The new version of the Russian MiGfighter... with its price, you can build a dam to irrigate 10,000 acres. You can build houses for nearly one million people with the money saved on one modern nuclear submarine... Ah... how senseless..."

"Yes' sir, I do agree," Parikshit said eagerly. "I have facts and figures which prove that we can turn the earth veritable paradise if only half the world's nations spend their five years' defence budgets on simple amenities and food."

"That's why I say, we are fools. These power-seekers... Ah, but sorry. I forget my manners. Where are you staying?"

"The tourist home at the hill station."

"Good. How's the place?"

"Charming.. rolling hills, green plains and the jungle. I never imagined you had such a lovely forest here."

Fernandes was pleased. He knew that Parikshit was here to interview him for his thesis on psychological conditions of soldiers during actual combat. That's why the General had set aside the morning for the boy. A bearer brought platefuls of hot, thick omlettes. Fernandes picked up a half roasted toast and said:

"Take some more butter, my boy. By the way, who pays for your travelling for the thesis? The University?"

"Well... no. Not for this subject. I have another project to assess the intellectual capacity of the aborigines. Financed by a social science institution. They pay me. Then I have a handsome scholarship for pure mathematics."

"My God, I thought you were a psychology student working on soldiers' psychological..."

"Of course..." Parikshit intervened apologetically. "I am studying psychology with the University. In fact, that's the subject I got a medal in." He was feeling embarassed now. "Still, my main interest is pure mathematics. I have a French scholarship that allows me to pursue some mathematical problems in my spare time..."

"Well... well. You seem to be quite versatile. What mathematical problems...?"

"Oh, its rather difficult to explain," Parikshit chewed a piece of toast. "It's like this. The present mathematical systems are rather inadequate to understand the relationship between time and space. Take for example integral calculus..."

"Enough. Enough...," Fernandes laughed, raising his fists dramatically with a fork and a knife in each. "I am not exactly a genius in mathematics. Let's talk about the subject I know. Eat plenty my boy and keep fit... well... Who told you to interview me? There are many competent professional psychologists in the armed forces..."

"Nobody. It was my own decision. You see, I talked to many officers of your time. And they spoke about you. They tell me if anybody knew of the soldiers' psychology really, it was General Fernandes. You see sir, you are quite famous.. I have heard stories... How you used to personally lead soldiers in the thick of battle... how they loved you..."

General Fernandes smiled. He knew his zeal for fighting and hand-to-hand combat had gone against him in the records. He was deemed "irresponsible". No officer of his rank was allowed to risk his personal life. In fact he had missed the top post in the army because of this proclivity. But Fernandes had no regrets.. He knew he was an officer of high calibre and he loved his soldiers. The soldiers loved him too despite of his famous profanities. Pamela was often embarassed by his legendary invectives.

Parikshit was not an ordinary boy, General Fernandes realised. He was intelligent. He had done his homework thoroughly. His knowledge of military affairs and the soldiers' psychology was astounding. Fernandes talked to him freely and answered his questions for more than an hour till Pamela came on the scene.

The micro-journey takes place beyond the restraints of space and time dimensions. Once you are in microspace you can land anywhere anytime...

"Come Pamy, help us finish this breakfast," he pointed at the empty plates.

Pamela ignored the joke, lit a fresh cigarette from the stub in her lips and served a large slice of toast to Parikshit.

"Eat, young man. You *are* frail. You must eat more." Then she turned to her husband:

"Darling, have you read the newspapers? Your stupid military people... What are you doing to this world...?"

"Oh, no, Pamy, don't provoke me..." Fernandes said. "I am against nuclear weapons, you know that. It's not a manly weapon. No fun in a nuclear war. War is a game, you know..."

"To you, to warmongers, may be it is a game... See what you have done. All those atom bombs... How I wish, we could horsewhip these warmongers and pack them off to Sahara. Their entire nuclear arsenal should be dumped into the Pacific ocean..." Pamela puffed at her cigarette violently.

"Now...now. Stop it darling." Fernandes said, turned to Parikshit and winked, "You know, she is a pacifist, one of those anti-nuke activists. She believes that I am the culprit responsible for all the trouble ..Ah, forgot to introduce you. Pamy, this is Parikshit Bhasme. Studying psychology of combat soldiers. And she is Pamela. Young man, don't be infatuated with her She is my wife. You may think she is a young lass. But she is getting old. How old are you darling? Thirty? Twenty-five? ha. ha. ..ha..ha ."

Again Pamela ignored General Fernandes' hamhanded attempts at humour. She lit another cigarette, as if by magic and served tea to Parikshit

"Don't pay any attention to his silly jokes. He is getting senile."

"Ah, come on That isn't fair I am not old. You know, young man. A strange thing happened this morning I go for a walk in that forest. And I lost my way today.. "

"Oh, it happens. "

"No...no I just can't lose my way. I know this jungle thoroughly," Fernandes' smile narrowed. "come to think of it Pamy, I am quite sure I did not see the meadow. You know, Parikshit, there is a grassy basin, right in the middle of the forest Few people know of it..." Fernandes stopped suddenly. His face clouded with hesitation and confusion.

"Yes, Pamy," he whispered, "I did not see that pasture today It was not there!"

Pamela laughed, showing her sparklingly white teeth. Parikshit was surprised but soon realised that they were dentures.

"Look, how miserable it is to be old. And I have to live with him."

"Honest, Pamy, I am positive. It was not there."

"Do you mean to say it vanished...?" Parikshit intervened eagerly.

"Well... ah... well... Yes, vanished... but..."

"Forget it darling. Get up and put on some decent clothes. You are supposed to meet the Navy people at 11."

Pamela winked at Parikshit and put her forefinger on her head, "Getting old, you know. Don't take him seriously. But you are a good boy. Come tomorrow for breakfast and stay for the lunch."

Parikshit was baffled and yet excited when he came out of the gate. How could that thing vanish? Incredible. And yet... and yet... His thoughts raced with electric speed.

WITH an imperceptible lurch the giant spaceship left the micro-space to enter the proto-space. The massive glass windows were suddenly illumined with millions of stars. Particles atomised during the micro-journey fused instantly, reviving the frozen life in the ship. But the duration of the micro-journey was so infinitesimally short, that it cannot even be felt. The micro-journey takes place beyond the restraints of space and time dimensions. Once you are in micro-space, you can land at any desired intersection of time and space almost at the same instant. How else could that spaceship arrive 1,500 light years away from its mother star system?

Shouts of jubilation resounded in the ship Commander Hemaketu looked through the glass window of his cabin. In the vastness of space, one star glowed especially bright and it was rapidly growing in size and luminosity. That was the target. He turned towards internal communication and the screen before him came to life. Chief pilot Vijeeta and her four colleagues were busy with navigating the ship.

"Congratulations," Hemaketu said, "Right on target "

"Right," said Vijeeta without looking up. Then becoming aware of her own terseness, she smiled mechanically at the screen and said, "Thanks."

That was dry. But Hemaketu could perfectly understand. Micro-space pilots were a special category. Above all, the women micros. Breaking the barrier of micro-space and landing at the exact desired intersection in proto-space was a demanding task requiring intense concentration and skilful capacity for making instant (and cool) decisions, an area in which women micros excelled. So they were much in demand, pampered and glorified.

"Vijeeta, how long will it take to enter this star system?" Hemaketu asked.

Vijeeta pressed a few buttons and without looking at the screen she replied, "Fifteen hundred matras."

"Good, good. Thanks."

Hemaketu shut off the screen. Fifteen hundred matras long enough to make decisions. A matra was an absolute unit of time evolved through complicated processes of juxtaposing relative speeds of different electrons and the average pumping rate of human heart.

Hemaketu pressed buttons to work on the information. With the press of another button, the boyish-looking Kalpaksha came on the screen. Kalpaksha was the most brilliant and gifted among the life-detectors. The computers did supply information about life. But the ultimate decisions were made by human minds and Kalpaksha excelled in this skill.

Young Kalpaksha was bubbling with enthusiasm. His eyes brightened when Hemaketu filled his screen. He raised his hands, "Hail commander."

"Hail!" Hemaketu responded. He liked Kalpaksha. And encouraged his friendship with his own daughter, Viplava, the universally famous musical prodigy.

"Congratulations, Kalpaksha. Your calculations are completely correct."

"Perfect," Kalpaksha laughed with boyish pride, "almost a replica of our own sun. Nearly the same diameter, luminosity, rate of energy emission and revolution. The difference is between zero point zero zero five and zero point zero one.

"Excellent."

"But I am wrong in one guess," Kalpaksha said with hurt pride. "I thought there were seventeen to twenty planets to this star. There are only ten."

"Doesn't matter," Hemaketu reassured him. "You studied this star from 1500 light years. Isn't it enough to detect a planetary system from such a distance?"

"Well, yes," Kalpaksha was reluctant Life-detectors were as sensitive as they were intelligent. Actually, an infallible system to calculate the strength of planetary systems of distant suns was yet to be found,and yet, talented life-detectors like Kalpaksha made inspired guesses. And one small guess going wrong meant a personal defeat for him. "Yes," he said, "but there are only ten. That means our choice is limited."

"Rejoice, Kalpaksha. Ten is enough. Now

get on to work. Soon we enter the system to encounter planets. What is your present reading?"

"The three outer ones sir, they are dead, useless..."

"One moment." Hemaketu recalled Vijeeta and said with cool authority, "Vijeeta, the three outer ones in the system. Located their positions? Avoid them. Avoid their gravity pull. If you want, use their tangents for finding direction. Now Kalpaksha, what else...?"

The star's shape was now clearly visible. Its mellow light could be discerned. The Spaceship still moved at hyper-speed.

"The fourth is interesting," Kalpaksha consulted his computers, "But only for its rings. Remember we noticed the same electro-magnetic phenomenon in the Z 294 system "

"No use wasting our time on it... one moment... Vijeeta, avoid the fourth one too. Keep to hyper-speed... Kalpaksha, now what...?"

The team got busy. This was the most critical phase of the mission. The computers fed the data about the system, each planet, its mass, size, temperature, gravity, atmosphere, rate of revolution. It was the job of the life-detector to intuitively sift the data and make the decision which planet could support advanced life.

"Number five: a thick layer of atmosphere," Kalpaksha busily relayed information "But, Ah .. What a mass and size. . no... impossible. We shall have to use all our anti-gravity fuel... difficult. . Well.. the sixth one looks promising. Ideal mass and size. Atmosphere too. Reasonable gravity field... should we go closer and peep in ..? Well really?.. But no. The temperature difference is too sharp. The atmosphere's not promising Couldn't support what we are looking for... No... let's go ahead.. The seventh one... Good. Interesting. Quite promising... Ah, Commander . on Universe...! Wonderful.. Ideal mass, size, atmosphere and gravity..."

"Make sure Kalpaksha. I won't like wasting time on a primitive sphere with primary life forms. We have had too many."

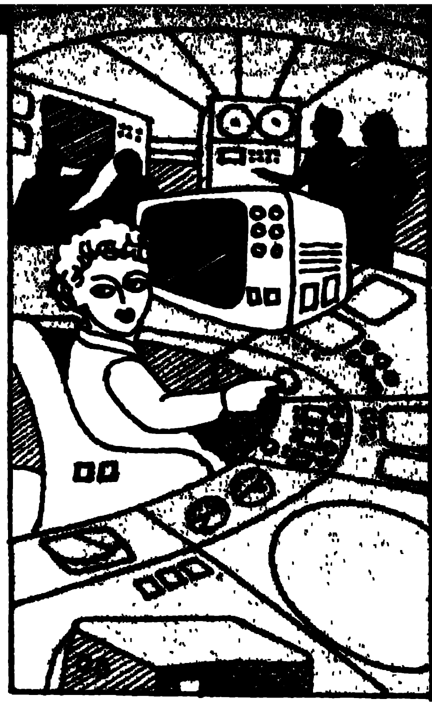
Kalpaksha let out a jubilant cry.

"Commander .. This is it. The seventh one, Ideal. Oxygen, carbon dioxide, water, atmosphere to protect it from space rays. Everything fits in. Let's peep in Commander."

"Are you sure Kalpaksha? How many moons?"

"One."

"Only one?"



"Don't hesitate Commander," Kalpaksha said. "It's a beauty. One moon doesn't change things. Don't expect every planet in universe to be the exact replica of our own Viplava."

"All right, guess I'll have to depend on you .. Vijeeta, closer to number seven don't touch its field yet..."

"Made one more mistake Commander .." There was jubiliant twinkle in Kalpaksha's eyes. Not a trace of hurt pride.

"Now what?"

"I told you there were ten. But actually there are only nine in this system. And this one is the seventh... Got it Commander?"

For a moment, Hemaketu could not grasp it. Then it dawned on him.

"Great Galaxy!," He exclaimed. "Nine planets. And this one is the seventh. Which means third from the sun Just like our Mother Planet Viplava... Oh, Universe. . Vijeeta..."

PARIKSHIT Bhasme was nonplussed when he left General Fernandes' bungalow He felt a slight stir in the stomach and a faint touch of dizziness. Some fantastic ideas crowding around in his head What was the connection of this morning's happenings with those brain-storming equations he was working on?

Parikshit looked beyond the bungalow There was a little slope, an uncultivated moorland half a kilometre wide and then the forest. For several moments Parikshit stared at the forest lost in strange thoughts.

General Fernandes was old. But he was fighting fit, in body and mind. Not at all senile. Then was he talking nonsense? Those mysterious formulae once again nudged him. His head began to reel. Parikshit almost ran upto the bus stand. The first thing he did after rushing into his room in the tourist home was to grab a pencil and papers. He began jotting down the formulae he was thinking about. It seemed silly to assume that Fernandes was talking of something sensible. And yet... he must work and find out.

In his bungalow, General Fernandes had a busy schedule throughout the day, however, the strange morning incident kept gnawing at his mind. What was going on? Had he lost his mind? He tried to laugh it away. But it would not go. The memory of the tangled forest would not leave him. Where had the meadow gone? How could it just vanish from the forest?

Just before he went to bed, the telephone rang. It was Parikshit on the other end. General Fernandes was rather irritated: "Yes, Parikshit, what is it?"

"Sorry to bother you, sir A question."

"Can't it wait till tomorrow?"

"No sir, its rather urgent..." No trace of diffidence now in Parikshit's voice. Instead, there was a cool authority. "It's about this morning, General. Are you sure the clearing in the forest was there till yesterday? Did it disappear only this morning?"

General Fernandes was taken aback by Parikshit's impudence. He felt annoyed. "How are you concerned with it boy?" he was about to cut the line when Parikshit firmly cut in.

"It's not mere curiosity, General. I am asking the question as a mathematician."

Mollified, the General fell silent for a moment. Then he asked, "But, how is it possible?"

"That means you are certain. I just wanted to confirm."

"What the hell .' General Fernandes warmed up and again fell silent. Then he whispered, "But its not possible. Tell me Parikshit, is that possible?"

Now it was Parikshit's turn to remain silent.

"Hullo. Parikshit.. are you there? Tell me, you know science Is that possible?"

The line snapped It was a long distance call from the hill station and General Fernandes desperately wanted to reach him. He wanted to send him his car so that they could talk. But then, he calmed down, laughed at himself and went to bed.

Commander Hemaketu decided to land. It was an important decision. For centuries, his people had combed the galaxies in search of just such a planet and here it was. He hoped desperately Kalpaksha's calculations were correct. That would be the most glorious achievement.

Before sliding into an extended orbit

The Viplavans make a jubiliant landing on the alien Earth. But is their intoxicated joy justified? What lies outside their ship? Read on in the next instalment

around the planet, a massive radio shield was raised around the giant spaceship. It was a safety measure. The advanced civilisation, if any on this planet—and by universe, it better be there—*should* not get panicky. The orbital observations positively confirmed the presence of a civilisation. Why, there were several artificial objects, though very primitive, orbiting around the planet. But they did indicate an intelligent mind and a developing technology. The spirits soared in the ship. The computers pointed at several deserted places as sites for landing. Hemaketu made the final selection. A green place away and hidden from the civilisation and yet not very far away. The ship lumberously lowered its orbit keeping itself in the shadow of the planet and elegantly glided down to land into a beautiful grassland surrounded by a thick forest. Hemaketu ordered the first mandatory manoeuvre, "Raise the invisibility shield."

The night was dark and the air was cool. The wall and ceiling of the massive foyer of the ship was transparent. The Viplavans admired the brilliant view of the sky of a foreign planet. A fixed time was set aside after the excitement of landing for relaxation and adjustment with the revolving speed of the planet. It took some time to overcome the massive space and time lag. The foyer was filled with people rejoicing, celebrating and eating. Mechanical robots served food and drinks. The faint background music changed and a hush fell on the hall.

"Viplava," a shout rose.

"Yes, Viplava... " Hemaketu said proudly. It was the music composed by his daughter. It also reminded the space-people of their mother planet, Viplava. Hemaketu, Kalpaksha and Vijeeta sat round a table for preliminary assessment while others relaxed. Hemaketu was immensely pleased to see Kalpaksha totally enamoured with the lilting tunes. But he couldn't fail to notice that Vijeeta was visibly annoyed partly because Kalpaksha liked the tune and partly because she also could not shrug herself off from the haunting, gripping music.

"Shall we start?" Vijeeta made supreme effort to disengage herself from the captivating tunes.

"Yes, let's start working," Hemaketu agreed, and pulled the computer data sheets before him.

The aliens relaxed and enjoyed the excitement of being on a foreign world while trained squads of robots meticulously performed their assigned talks. A group of robots stepped outside the ship for collecting basic physical data as required by law. No alien could leave the ship and expose himself to the foreign environment till the data supplied by robots was carefully analysed. The most important test the robots were to do was about the quality and toxicity of bacterial presence. Aliens could leave the ship only after confirmation that the bacterial presence was totally harmless. Meanwhile, the ship and a part of the lawn outside was comfortably ensconced in a transparent dome of invisibility.

"Do we have to activate our gravity-equaliser force?" Hemaketu asked.

Kalpaksha consulted the charts. "What do you think Vijeeta? The gravity force here is zero point nine four nine compared to our own Viplava. Hardly a difference of zero point zero five."

Vijeeta looked around. There was an exileration and dance in everybody's steps, eyes bright and an intoxicating freshness in head. That was the effect of this zero point zero five difference. She weighed ninety units on Viplava, slightly overweight considering her height and age. Here, she would weigh eighty-five point four one units. Ideal.

"No need," she said with a grin, "Its so cheerful..."

"Good. Now, let's take each parameter one by one... atmospheric pressure, its contents.... oxygen... temperature variations... energy emissions..."

The robots automatically fed data to the computers beside the table. Each sheet was carefully scrutinised.

"Bacteria...?" Hemaketu whispered bending eagerly over the last perforated sheet." By Universe, can it be possible, "he stumbled, "perfectly safe, even better than our own Viplava..."! he handed over the paper to Kalpaksha.

Kalpaksha glanced at the paper and jumped up with an exultant cry. He whisked Vijeeta up from the chair, held her high and planted a massive kiss on her mouth. "Eeeeoooooh..." he cried.

Everybody knew what it meant. Shouts of joy rent the air. All left their tables and began crowding around Hemaketu's group.... "Buck up..." ... "Cheers...." ... "Congratulations...." .... "Now, announce it Commander...." they shouted. Most occupants of the ship were highly specialised experts, technicians, scientists, biologists and sociologists.

Hemaketu disliked Kalpaksha's exultation, especially his demonstrative bussing of Vijeeta. He had to make the formal announcement. He rose from his chair, cleared his throat and began sombrely.

"Friends, this is a great moment for our civilisation, a giant leap for the humans of Viplava. This moment shall be preserved on a platinum film.... At last, our quest through centuries and galaxies has yielded....."

"Oooh... no speech..."".... "Just the announcement...." People knew their Commander's penchant to make speeches.

"Well... I am glad to announce that our host planet, which apparently has some kind of advanced civilisation, is absolutely free of harmful bacteria..."

Shouts of joy, whistles, clappings. Some even began dancing. A few youngsters cried... "Let's go... come on..."

"Wait... wait..." Hemaketu raised his hand. "You know our rules. There are still more tests to be completed. We shall see the sunrise here soon. Till then, we are not supposed to step out. Meanwhile, each of you will get the basic information about this planet on tapes which you can study on your personal screens. Our host is an ideal planet. Most parameters compare well with our Viplava. You might experience a light-headed feeling, a spring in your legs, freshness and a youthful intoxication. Don't be carried away. You are not younger even by a matra. Its the effect of zero point nine four nine gravity here...."

Hemaketu's humour was not lost. Some of the elder scientists smiled tolerantly.

After the crowds dispersed for rest and study in their respective rooms, an elderly physicist approached Hemaketu's table.

"Congratulations, Hemaketu, for this monumental achievement..."

"Thank you, Dnyanamagna, but you must congratulate these young people, its their achievement, Kalpaksha, Vijeeta," Hemaketu said magnanimously.

Dnyanamagna ignored this. He was a typical specimen of a scientist. Ill-fitting clothes, an irregular beard, long white hair and lost eyes.

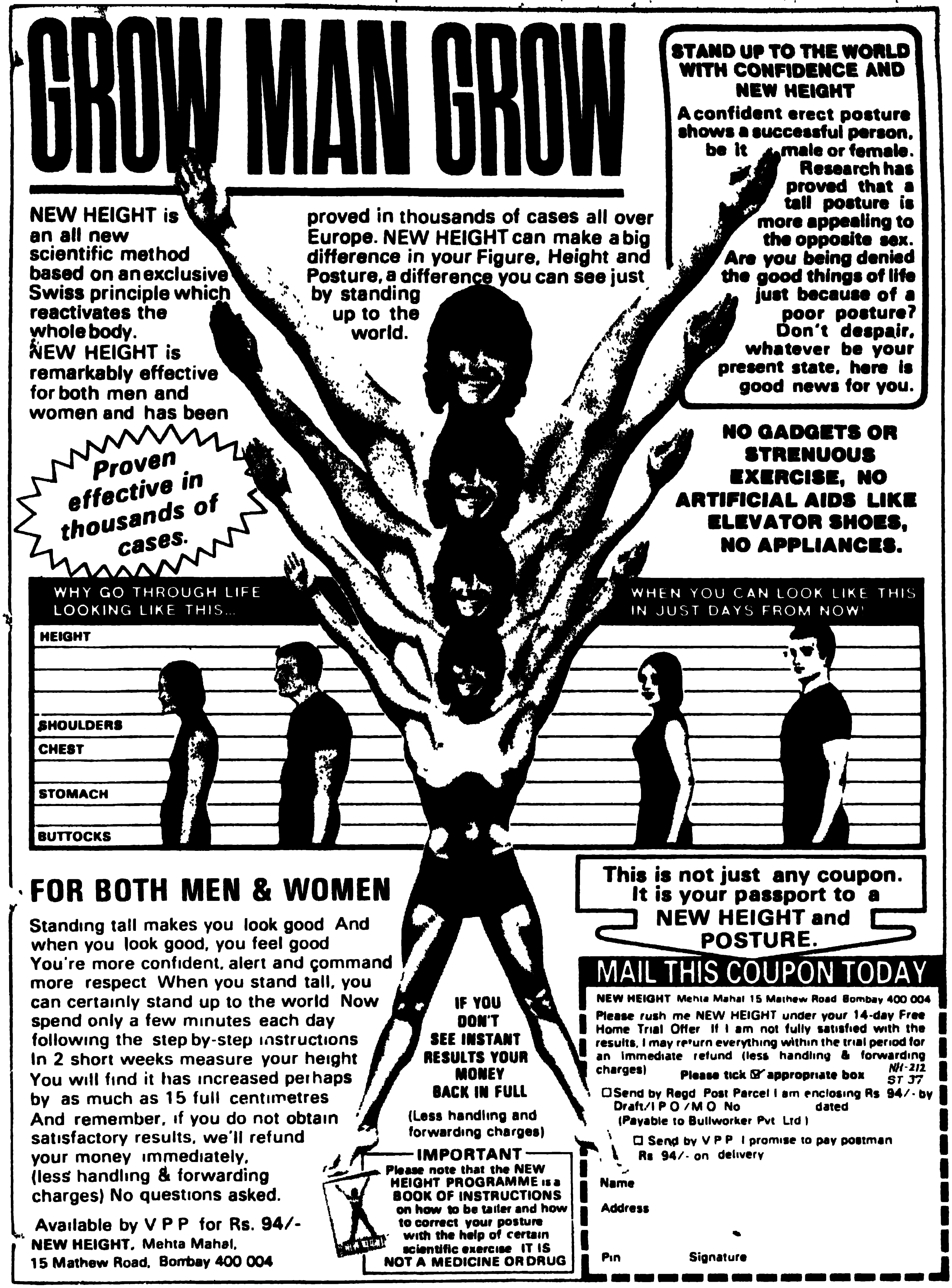
"What about nuclear energy...?" he asked.

"Well, we have detected heavy radiation But you see, apparently they have not used nuclear energy in their primitive satellites. We shall have to go out to see...."

Dnyanamagna shook his shoulders, adjusted his glasses, turned back and went away without speaking another word...

To be continued

Mr. Sadhu, the Bombay representative of The Statesman, is a well-known Marathi novelist and short story writer.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ATOMIC APPAREL

C. K. Gupta

ZIRCONIUM remained for long the problem child of metallurgy as it is exceedingly difficult to free it from its ores, which, however, are abundant in nature. Once the metal was drawn out of its hiding, not only has it been good in behaviour but also has come up with many delightful surprises. The properties that make its extraction inherently difficult and expensive are its high melting point combined with a suicidal affinity for gases when hot: the metal can dissolve virtually anything when molten, including brick.

This silvery grey metal is somewhat lighter than steel and quite strong. It has a remarkable resistance to corrosion except against hydrofluoric acid. In anticorrosion properties zirconium is close to tantalum, being even superior in its resistance to alkalies.

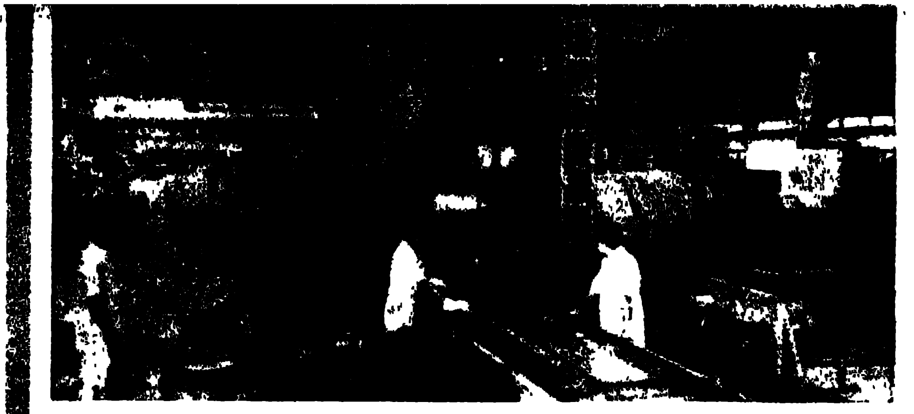
Among the many virtues the metal is endowed with, the most important, perhaps, is its low absorption of slow neutrons. This property along with its added strength, corrosive stability and workability makes it attractive for cladding fuel material in nuclear reactors. Though aluminium too has a low absorption capacity for slow neutrons the corrosion resistance and the strength at high temperatures tilt the balance in favour of zirconium. However, there is one unfortunate aspect of this which needs to be mentioned here. Zirconium ores normally contain about two per cent of hafnium an element closely related to zirconium. Though the two are identical in their chemical behaviour, hafnium has a much greater capacity for slow neutron absorption (700 times more). For this reason, it is necessary to bring down the hafnium content to less than .02 per cent in nuclear-grade zirconium which by no means is an easy task. In fact, there is a greater similiarity between this pair than any other pair we come across in the periodic table.

Discovery and properties

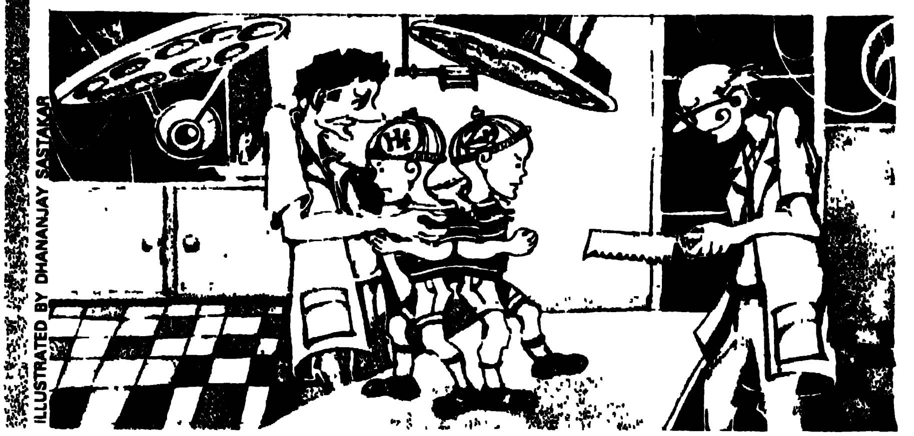
The discovery of zirconium goes back to 1798 and is credited to the famous German scientist, Martin Klaporth. Since its discovery Klaporth's metal waited behind the scene until the true calling for the metal came with the advent of worldwide nuclear power programmes. A phenomenal change has, since, come about in its status. Today, one witnesses the destiny of the metal to be closely interlinked with that of nuclear power programmes.

Zirconium occurs in nature com-

Zirconium in non-nuclear industry. A. Heating coil. B. Cast pump casing and cast valve bodies. C. Tube and shell heat exchanger



Rolling mill facility for zirconium fabrication



ILLUSTRATED BY DHANANJAY SASTAKAR

Traces of hafnium will make zirconium useless for nuclear use

bined with silicon and oxygen as zircon sand, zirconium orthosilicate. The difficulties in its extraction and metallurgy have made it belong to the class of rare metals though, in nature, it is more abundant than all the nickel, copper, lead, zinc, tin and mercury combined. Zircon is the most widely distributed zirconium mineral whose zirconium content varies from 61 to 66.8 per cent and is found in the beach sands of Florida, India and Australia. Another zirconium mineral, the second most important, is baddeleyite which is the native form of the oxide or zirconia. It is available in Brazil and South Africa. This source of Zirconium goes mostly for the chemical markets.

The metal is described as refractory (high melting point) and reactive (extremely sensitive to impurities particularly gases). These characteristics have, in fact, made zirconium metallurgy vastly different The refractory nature rules out the extraction of the metal in molten condition from large furnace installations, the familiar scene in common metal extraction. The reactive nature of the metal (the great affinity for oxygen, nitrogen and hydrogen) dictates that the metal be protected at every stage of processing either by a blanket of inert gas or vacuum. As little as a few parts per million of these gases utterly ruin the working properties of the metal, rendering it brittle. Hydrogen impurity is somewhat easy to control, as during the production of ductile zirconium hydrogen gets pumped off. The case of oxygen and nitrogen is quite different and once they report to the metal, there is no way of getting rid of them completely

Zirconium chemistry provides a number of other unusual aspects. Its compounds range from strongly acidic through neutral to strongly basic, a behaviour unlike many other inorganic compounds, where one expects a range from neutrality to either acid or alkaline compounds, but not both.

Uses of Zirconium and its compounds

The current annual production of zirconium metal amounts to about 4500 tonnes with the nuclear industry being the major consumer. Water cooled reactor systems including boiling water, pressurised light and heavy water types make substantial use of zirconium for fuel cladding and structural components. An alloy of zirconium with small proportions of other elements rather than pure zirconium is used in these applications. The alloys retain the desired properties of the pure metal and also perform better in the nuclear reactor environment. Zircaloys, zirconium-niobium, ozhenite, zirconium-niobium-copper, are well known examples of alloys of zirconium presently in use.

Zirconium has found a number of non-nuclear applications. Special mention may be made of applications (i) in the chemical process industry—in heat exchanger tubes, valves, pumps, (ii) in incendiary applications as finely divided metal powder, (iii) in grain refining, and as hardener, in aluminium and magnesium alloys, and (iv) in deoxidation, and grain growth inhibition in steels In the figure some typical zirconium products used in industry are shown

The application account would hardly be complete without mention of zirconium compounds Heavy mineral zircon sand blends have foundry and sand–blasting uses. Zircon-based foundry sand was reportedly designed to provide high quality performance at low cost for critical casting applications. The zirconium mineral, baddeleyite finds uses in the manufacture of alumina-zirconia abrasives and also in ceramics and refractories. Zirconium chemicals are being used increasingly in the paint, textile and phar-

Kroll process

WILLIAM J. KROLL, who conceived and developed the magnesium reduction process for both titanium and zirconium is considered a legendary figure of metallurgy. He was invited, in 1945, by the US Bureau of Mines Research to initiate a process for producing ductile zirconium as he had done earlier for titanium. His one man orchestra, as he himself put it, was successful and Kroll with his co-workers set up a pilot plant with a capacity of 60 pounds of zirconium sponge at Albany, Oregon, [illegible] of iodine. The [illegible] yields the highest purity metal and is used even today to meet [illegible] needs. Kroll process yields somewhat lower purity metal but in sufficiently large quantities. Kroll-reduced metal is good quality ductile material and goes through melting, casting, alloying and fabrication processes to attain its final forms as required by the various applications.

A view of the Kroll assembly as used in Nuclear Fuel Complex at Hyderabad is shown here.

USA. This was later extended to a larger pilot plant. It was so successful that in August 1950, the Bureau of Mines completed and operated at Albany, a full size Kroll-process which bears the distinction of being the first major zirconium plant in the world. The production of pure zirconium for the first time had come about much earlier, however. The credit for this goes to two Dutch investigators, Van Arkel and De-Boer who had

In honour of the renowned metallurgist, who founded entire new fields of technology, W. J. Kroll zirconium medal has been established to recognise outstanding achievement in the scientific, technological or commercial aspects of zirconium production and utilisation and to encourage future work in this field. The award is made by the W. J. Kroll Institute for Extractive Metallurgy in USA.

C. K. G.

maceutical industries. Among the zirconium compounds, the most important, perhaps, is zirconia. The bond between zirconium and oxygen is extraordinarily stable, and can withstand unusually high temperatures. This asset makes the material ideally suited for high temperature applications. Zirconia is a very popular refractory crucible material. Partially stabilised zirconia ceramics in the system zirconia-calcium oxide have great capacity to withstand thermal shocks. Calcia stabilised zirconia is an excellent high temperature solid electrolyte. The ultrahigh temperature MHD (magneto hydro dynamics) power generating systems use stabilised zirconia as electrodes. Zirconia has the remarkable ability to emit light intensely, upon heating, that it is used in illumination engineering.

Zircon to Zirconium

Zircon sand is known as a gem mineral from Biblical times: it is called jargon in Sri Lanka and hyacinth in France. Zircon probably comes from the Arabic *zargon* for gold or the dark ember colour of the common gemstone. Zircon is a highly refractive material as is evident from its geological stability. It is cracked only at high temperatures and with strong reagents. Zircon traverses a long route before yielding zirconium. Broadly speaking, these are the four steps involved in zirconium production.

The first step is the chemical breaking down of the mineral. The objective is to obtain water soluble zirconium in a form compatible for the next stage. Milled zircon is fused with caustic or caustic soda to produce sodium silicate and sodium zirconate. On leaching with water, a hydrous zirconium oxide is obtained which is soluble in strong acids.

The second step is for separating zirconium from hafnium by solvent extraction. The commercial system in

[redacted]

use are zirconium chloride-thiocynic acid-methyl isobutyl ketons, zirconium nitrate—tributyl phosphate-kerosene and zirconium sulphate-tri-N- octylamine. Reference must be made at this point to another method which has been successfully employed as a separation technique, the pyro-chemical process. The major drawback of the solvent extraction process is considered to be the pollution problem arising from nitrogen containing salts and organics present in the aqueous effluent.

The pyro-chemical process begins with anhydrous chloride obtained from chlorination of zircon sand and coke and operates either on the greater volatility of hafnium tetrachloride over zirconium tetrachloride from a multi-component molten salt, or on the greater ease of reducing zirconium tetrachloride to less volatile trichloride. Separated chloride directly goes for reduction. Separation involving the use of molten salt extraction system has until now shown considerable promise. A plant has already been built in France. This trend of solvent extraction being given up in favour of pyro-chemical process is likely to continue in nuclear-grade zirconium production.

The third step following solvent extraction is the production of anhydrous chloride. The chlorination process essentially involves the reaction of hafnium-free zirconium oxide (solvent extracted and processed) with carbon and elemental chlorine. The tetrachloride vapour gets collected in the condensing units attached with the chlorinator.

The last step is the Kroll process, reduction of the chloride with magnesium. The process consists of sublimation of zirconium tetrachloride to a bath of molten magnesium in a batch reactor maintained under a protective atmosphere of helium or argon. Magnesium, because of its greater chemical activity, takes up the chlorine bound with zirconium. Solid zirconium on account of its high density settles beneath. Less dense molten magnesium chloride resides below the molten

magnesium on account of its being the lightest among the three components in the reduction. Molten magnesium thus rests at the top and makes itself available to react with the incoming tetrachloride vapour and the cycle continues till the conclusion of a given reduction batch. The excess magnesium and the magnesium chloride are then drained and distilled away. The process yields zirconium in a grey sponge form. The magnesium reduction process for zirconium is more popularly known as Kroll process (see box on page 72).

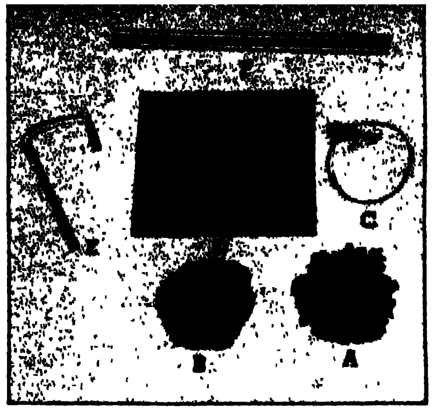
Zirconium in the powdered form is another industrial requirement for the metal as pointed out earlier. There are two ways that are in vogue for powder production; one starts with the oxide and the other with the metal. The oxide process involves chemical reduction with either calcium or magnesium which on account of their higher affinity for oxygen reduce effectively the oxide to the metallic state. The other powder preparation method involves hydriding of the source metal, comminution of the hydrided metal, and finally dehydriding.

Powdered form of pure zirconium needs to be handled with care as it can catch fire and burn easily. Large amounts of the metal dust present in the air can lead to explosions. Very fine powder, which needs an inert atmosphere or vacuum for storage, finds application in photo flash lamps.

Indian Scene

There is no dearth of zirconium resources in India. Our country, in fact, ranks well with other countries noted for zirconium reserves. The principal source in India is zircon which occurs plentifully in the alluvial beach sands of Tamil Nadu and Kerala and also in the placer deposits of Ranchi plateau (known reserves are placed over five million tonnes).

The story of zirconium in India dates back to the early fifties. It started with a reference by the Department of Atomic Energy to the Metallurgy Department of the Indian Institute of Science at Bangalore for initiating extraction and process metallurgy development work on zirconium utilising indigenous resources. The programme was later brought to the Bhabha Atomic Research Centre at Trombay, Bombay. All components of the flowsheet starting from zircon to finishing with reactor-grade metal production and going beyond to melting, casting, alloying and fabrication technology for reactor application, have been extensively researched and developed upto pilot scale. These efforts laid foundation and provided the requisite engineering and technological inputs for setting up a fully indigenous production plant at Nuclear Fuel Complex at Hyderabad for meeting the requirement of the metal for the nuclear programme in the country. Successful operation since plant establishment in early seventies provides ample testimony to the capabilities and competence of Indian scientists and engineers for handling this special technology.



Some indigenously produced zirconium products. A. Magnesium-reduced sponge B. Calcium-reduced powder. C. Wire. D. Rolled sheet. E. High purity crystal bar. F. Zircaloy tubes for containing uranium oxide fuel

The present Indian practice begins with the caustic fusion of zircon. Solvent extraction coming next, is based on the nitrate-tributyl phosphate-kerosene system. Prior experience in uranium extraction and refining, and the possible use of stainless steels as suitable construction materials dictated this particular choice of the solvent extraction system. The flowsheet further on goes over to zirconium oxide chlorination in which first the oxide and petroleum coke powder mix is wet extruded and coked. The chlorination of the coked briquettes is then accomplished in a self-resistively heated heavy duty silica-brick lined shaft furnace. The chloride vapour coming out of the chlorinator is condensed in the attached assemblies kept somewhat hot. This facilitates chloride condensation in dense form, simultaneously resulting in the elimination of a large portion of associated volatile chlorides of boron, silicon, titanium etc. Redistillation of raw chloride in hydrogen becomes to some extent necessary in large volume production to achieve strict control of iron impurity. The purified chloride next passes through magnesium reduction and vacuum distillation cycle and ends up as zirconium sponge which is later melted, alloyed and fabricated to tubular products for power reactor application.

Apart from the reactor-grade metal there is also some production of powder metal mainly for meeting the internal market. Powder production utilises, at present, the hydride-dehydride process with the off-grade zirconium metal source. The programme however was initiated with the adoption of calcium reduction process. The change over later to the hydride-dehydride route was economically more justifiable and preferable too. Calcium is by no means a cheap reductant. Its indigenous availability is nil and therefore its use meant continued dependency on imports.

Nuclear energy in India bears, today, an expanding outlook. Programmes are being launched for the setting up of new nuclear power plants. Zirconium is destined to play its due share in this expansion and the metal's nuclear future stands very much assured in the indigenous scene. We can expect a good number of modifications and process improvements; possible replacement of solvent extraction by pyrochemical process, to cite an example. Zirconium production technology is poised well in India to significantly figure with the leading zirconium programmes in the world. □

Dr. Gupta is Head, Extractive Metallugry Section, Metallurgy Division, Bhabha Atomic Research Center, Bombay

The Answers

(Continued from page 39)

1. Red spot:—C: The Great Red Spot is a semipermanent salmon coloured marking of on the planet Jupiter.

It is estimated to span some 40,000 km × 13,000 km and exhibits a deeper tint in some years. The Jovian Red Spot has existed since observations of details on Jupiter were first made—about 300 years ago. The gas in the Great Red Spot is found to have a 12-day counterclockwise rotation period. At present very little is known on the Jovian Red Spot and its true nature remains elusive.

One school of thought suggests that the Red Spot, is the top of a gas column that arises because of an obstacle in the lower part of the Jovian atmosphere. The presence of this obstacle is not proved. Other astronomers are of the opinion that the Great Red Spot represents a giant eddy.

3. Yellow salt:—D: Also known as uranyl nitrate $UO_2(NO_3)_2\ 6H_2O$, yellow salt, is a toxic, explosive, unstable yellow, crystalline substance. It dissolves in alcohol, ether and water. It melts at 60°C and boils at 118°C. Its characteristic yellow colour is due to the presence of the uranyl ion. Uranyl nitrate finds applications in photography, medicine, uranium extraction and uranium glaze preparation It is also called uranium nitrate.

2. Orange lake:—D: The term 'lake', in dyeing refers to any coloured organic dye that has been rendered insoluble by interaction with a metal compound. The interaction may involve the precipitation of a salt, in which the proportions of dye to metal are fixed, or it may be a less well defined attraction between the dye and the particle surfaces of the metal. Orange lake refers to any of the various transparent orange pigments that are formed by the precipitation of an orange dyestuff on aluminium hydrate or any other base. (Dyes of several chemical classes including mordant dyes and basic dyes can be made into lakes.)

Lakes extend the range of colours available for paint, cosmetic and ink production They are also used to colour utility items.

4. White rainbow:— D. Fog bow, mistbow or white rainbow is a faintly coloured circular arc similar to a rainbow, but formed on fog layers containing drops whose diameters are of the order of 100 micrometers or less. White rainbows have featured often in mountaineering lore Perhaps the saddest story involving white rainbows is that of the party led by Edward Whymper an artist and ardent climber He led a group of 19th century mountaineers, who were among the first to scale the Matterhorn They are said to have glimpsed a white rainbow framing a series of crosses just after an accident in which many of them lost their lives Whympers sketched his vision for posterity.

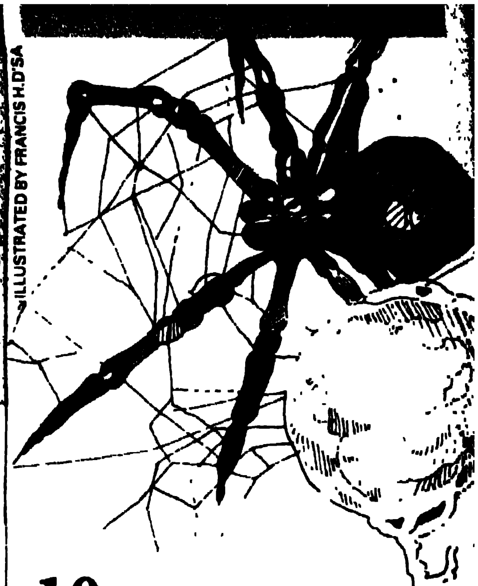
5. Green's dyadic:-A: Green's dyadic is a mathematical term. It represents a vector operator which plays a role analogous to a Green's function in a partial differential equation expressed in terms of vectors. Green's function is a function associated with a given boundary value problem, which appears as an integrand for an integral representation of the solution to the problem.

6. Blue bottle:—C· The blue bottle *Physalia utriculus* is a marine invertebrate dreaded by swimmers in and around the Indian Ocean. Also known as the Portuguese man-of-war, the animal inhabits warm seas throughout the world, and is often seen along sandy shores, where it looks like an inflated plastic bag with bedraggled yarn trailing behind it The body consists of a translucent pink, blue or violet tinted gas-filled bladder-like float, beneath which are clusters of polyps with tentacles that stretch behind it like wet blue wool. The *Physalia* bear nematocysts or stinging cells, that paralyse small fish and other prey, prior to digesting them. Its tentacles are constantly regenerated. The blue bottle's sting is dreaded and with good reason. It is very painful to man and can cause serious effects including fever, shock and interference with heart and lung action

7. Silver fish:—A. Silver fish *Lepisma saccharina*, are slender, flat, wingless insects with three tail bristles So called, because of their silvery scales and quick silver movements, silver fish belong to the wingless insect order *Thysanura*. Distributed worldwide, they eat their way into libraries around the globe. They consume materials with high percentages of starch, including paste, book bindings, wall paper and some fabrics. Between five to ten millimeters in size, they live for about seven years, during which they moult 40 times. They are destroyed by poisonous baits and other insecticides.

The Winners

WE RECEIVED an avalanche of mail for our June quiz. The winner is Tushar R [illegible] of 24 Parganas, West Bengal. He sent us a list of 955 words—a tremendous feat. N. Balaji of Madras, won the May 84 competition. Congratulations!



8. Graywacke: —D: is a variety of sandstone, rich in clay and grains of heavy minerals. The name graywacke (from the German *Grauwacke*) was first used by the German mineralogist Abraham Werner in 1787. It describes the colour and texture of the rock. Graywacke is the name generally applied to dark-coloured, strongly bonded sandstones containing rock fragments, feldspar and quartz of sand size. Almost all graywackes originated in the sea and were deposited in deep water by turbidity currents. Graywackes differ in colour, depending on their composition but are all various shades of gray. Graywackes are found to be associated with mudstone, shale, argillite and slate. Volcanic graywackes do not show diagenetic (or burial metamorphic) effects. Graywackes are taken to indicate tectonic activity (folding and faulting) in the Earth's crust.

9. Gold leaf: —D: Gold leaf is rolled or beaten gold, of extreme thinness (approximately two nanometers), used for decorative work. Gold leaf preparation is a 'descendant' of gold beating, a craft which dates back to antiquity. Homer refers to it and medieval manuscripts gleam with gold leaf, which was also used in tempera work and gold tesserae. Gold tessera is a type of mosaic, first used by the Romans. It comprises of gold leaf encased in 'glass' chips. It became popular around 300 AD for use in wall murals and mosaic decorations.

Gold leaf preparation is a tedious process. Traditionally, a hammer and an anvil were used to beat the gold into ribbons which were later cut into squares. The squares were then encased in sheets of vellum or heavy paper and sheep skin and rebeaten to a still finer thinness.

10. Black widow: —A: A deservedly bad reputation shrouds black widows—spiders of the genus *Latrodectus*. The females of the species, devour their partners, soon after mating. The unfortunate male, doesn't stand a chance, he is one-fourth the size of his wife! Black widows belong to the insect family *Theridiidae* and the order *Araneida*. There are six known species, which are all toxic to man. Their bite produces pain, nausea, and mild paralysis though most bite victims recover without serious complications. Insects also feature among the black widow's diet preferences.

Professor Brahm Prakash (1912-1984)

THE Indian metallurgical community is organising a national seminar in honour of late Prof. Brahm Prakash during August 21-23, 1984, in Hyderabad. An eminent metallurgist, Dr. Prakash contributed immensely to the development of nuclear and special alloys metallurgy in the country.

Dr. Prakash, in 1957, as director of the Metallurgy Group in the then Atomic Energy Establishment was responsible for the country's first nuclear fabrication facility at Trombay. Under his leadership, the knowhow for the extraction and fabrication of a variety of reactive, refractory and radioactive metals, particularly plutonium metallurgy and fuel fabrication, was developed.

During 1957-1972, Dr. Prakash was responsible for the establishment and operation of a number of important industrial projects in the field of metallurgy. The Nuclear Fuel Complex and Mishra Dhatu Nigam Ltd., both in Hyderabad, are examples of his contribution to the country's efforts towards self reliance in frontier technologies of producing fuel elements for nuclear power reactors, and a variety of special alloys for defence applications.

Many honours naturally came to him—the Padma Shri in 1961 and the Padma Bhushan in 1968 for his contributions to nuclear metallurgy, the Bhatnagar Memorial Award in 1963, VASVIK award in 1976, Bhatnagar Medal of the Indian National Science Academy in 1979 and the Bralco Medal of the Indian Institute of Metals in 1980.

He was closely associated with the Indian Institute of Metals and was its president during its silver jubilee celebrations in 1972, when the major divisions of metal sciences, iron and steel, and industrial metallurgy were formed. Special mention should be made of his contribution as Scientific Secretary (from India) to the organisation of the First International Conference on the Peaceful Uses of Atomic Energy in 1955.

An article on zirconium metallurgy, a subject close to his heart, appears on page 70 as homage to this great metallurgist who passed away early this year, on January 3, 1984.

EASY METHOD TO DETECT JAUNDICE

INFECTIVE hepatitis, commonly known as Jaundice, is endemic in many areas of the country. In big cities, contamination of drinking water has created a chronic hazard in this respect (SCIENCE TODAY, August 1984). Therefore, there is an urgent need for a simple and cheap method for detecting the onset of the disease in the early stages.

A very early indication of infective hepatitis is the appearance of the bile pigment bilirubin in urine. In healthy persons, this pigment is present in only very small traces in urine. However, the onset of hepatitis causes significant amounts of this pigment to be excreted in urine and detecting this is a reliable way of diagnosing infective hepatitis.

The conventional method for detecting bilirubin in urine involves several time-consuming steps such as precipitation of the pigment, filtration and the use of a colouring agent. Moreover, this method needs trained technicians, is relatively expensive and can be performed only in a biochemical laboratory Strip and pad type of tests developed abroad, using specific colouring agents are available but are not in use in India.

The Chemistry Division, Bhabha Atomic Research Centre (BARC), Bombay, has developed a simple, cheap and reliable strip for the quick detection of bilirubin in urine. With this strip, detection of bilirubin takes less than half a minute compared with the 20 minutes required for the conventional method. The test can be performed by untrained persons.

The new technique uses a detecting agent encapsulated in a radiation cross-linked hydrogel. The gel is selectively permeable to bilirubin only and keeps the other pigments out. The gel is a kind of adhesive bonded to a white plastic base to provide a background for colour observation.

In a test the strip is dipped in the sample of urine for 15 seconds, then in water for a second, and taken out and observed. Presence of abnormal amounts of bilirubin is indicated by the appearance of a clear yellow colour in the strip. The strip is sensitive to about 0.1 mg of bilirubin in 100 ml of urine.

After being tested at the BARC Hospital, the strip was independently evaluated at the Kasturba Hospital, Bombay The tests have shown that the strip is reliable, simple and convenient to use. The cost of the strip is minimal and it can find large scale use, especially in rural areas.

C. Copinathan

Mr. Copinathan is with the Chemistry Division, Bhabha Atomic Research Centre, Bombay

Data transmission through telephones

THE Posts and Telegraphs Department is gearing itself to make the most of modern day communication facilities. The system of data transmission on Public Switched Telephone Network (PSTN), the P&T is advocating, is meant to accelerate efficient use of the large telephone infrastructure we have and also boost the use of personal computers in the country.

The PSTN offers avenues for people to process data at the residence or office without the need to carry it from place to place. The telephone subscribers who also have a computer at their disposal can call any other computer—national or international—on subscriber trunk dialling (STD).

The system involves at either end a computer terminal, an interface, a modem and a telephone. At the data transmission point the computer provides data to the modem through the interface. The modem converts the digital information to an analog signal and transmits it in a voice range that is audible over ordinary telephone lines. At the receiving end, the procedure is reversed and the data is processed. The terminals can process data at a speed of 1,200 bits per second.

The system can be put to several uses including essential services like airline and railway bookings, exchange of data and information between branches of commercial establishments, institutions and so on.

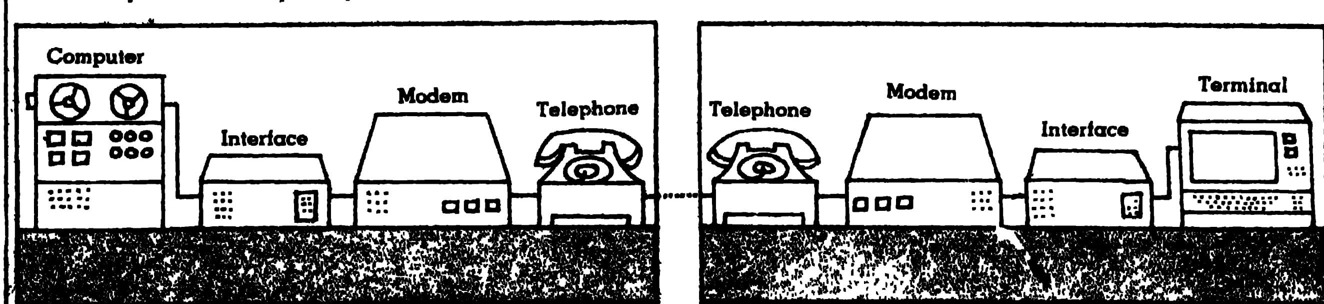
The modems and other accessories needed by the computer owners for data transmission are manufactured by Hindustan Teleprinters, Madras, and are rented out by the P&T for Rs. 3,000 per annum.

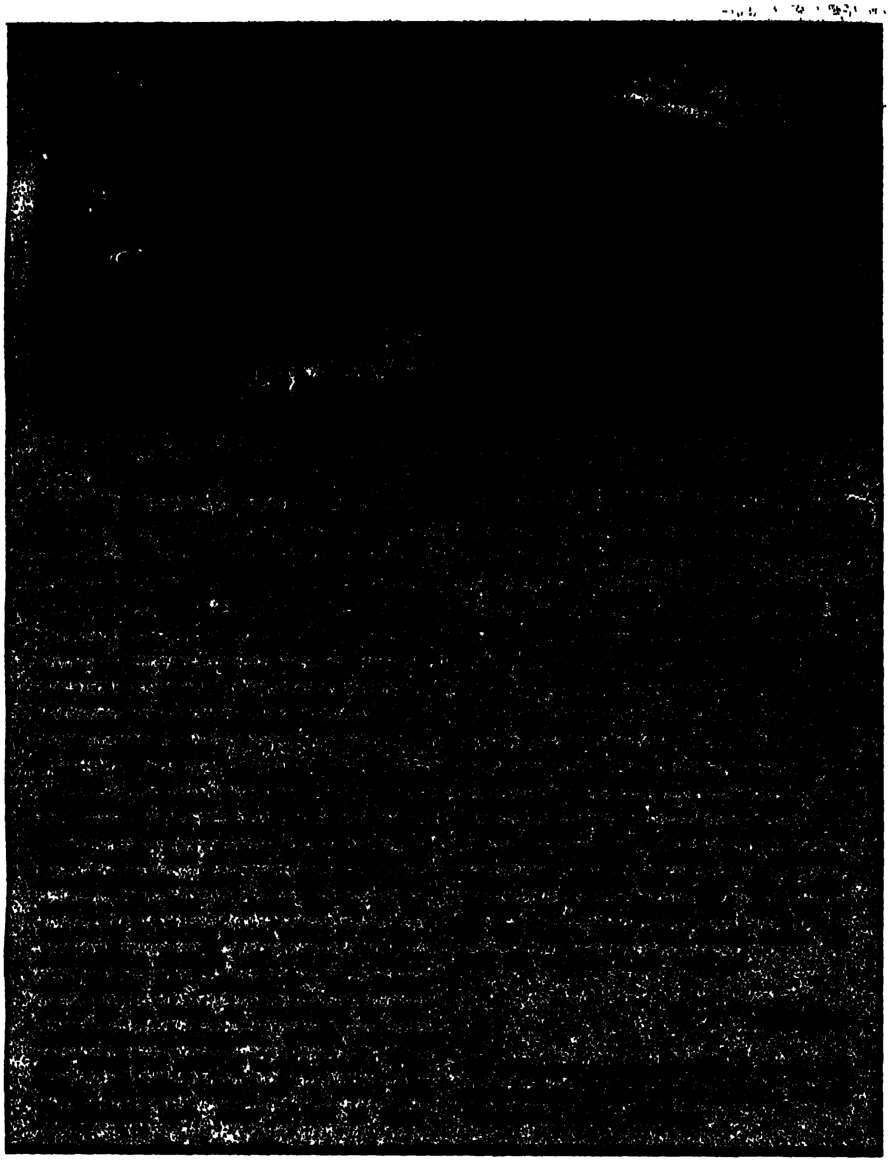
Meanwhile the Indian Telephone Industries Ltd., Bangalore, has produced a computerised programmable electronic display board, a new concept in outdoor advertising. It enables graphic designs and messages to be shown in colour animation.

The display board consists of modules capable of displaying six or 12 characters. The modules can be stacked either horizontally or vertically as required. The frequency, sequence and speed of display are automatically controlled.

The control system uses standard 8085 microprocessor through which all the entries, additions or deletions are carried out. Fixed messages can be stored in custom-made ROMs (read only memories). There is battery back-up to meet power failures.

The important features of this system include bright visibility from long distances and animation of visuals.





Communication by wrist radios

MAKING calls on wrist radios could be possible by early next century using a giant space antenna in the orbit, being developed by Lockheed Missile & Space. Company (LMSC), in the US.

The anatenna, which eventually could measure up to 200 m in diameter, would be able to receive low-power signals from earth and rebroadcast them at high power to designed areas.

Thus a small, low-power wrist radio with a simple antenna could transmit sound to a large part of the world, relayed by the antenna-satellite acting as switchboard.

LMSC's programme manager Mr. Nicholas F. Garcia says "Remote areas without telephone lines, such as Alaska and Canada's far north, could benefit greatly from such a high capability antenna-satellite."

It is a quick and reliable means of communication. It would be valuable to exploration teams. Other potential uses for it are radiometry observations important to agriculture, radio astronomy and radio telescope applications.'

A segment of antenna which was tested recently consisted of four 27 m-long flexible ribs made of graphite exposy and connected by a gold-plated fine wire mesh.

The ribs and mesh structure are wrapped around a central core in a compact package suitable for transport on the Space Shuttle, from which it would be launched into geosynchronous orbit 35,880 km above the Earth's equator.

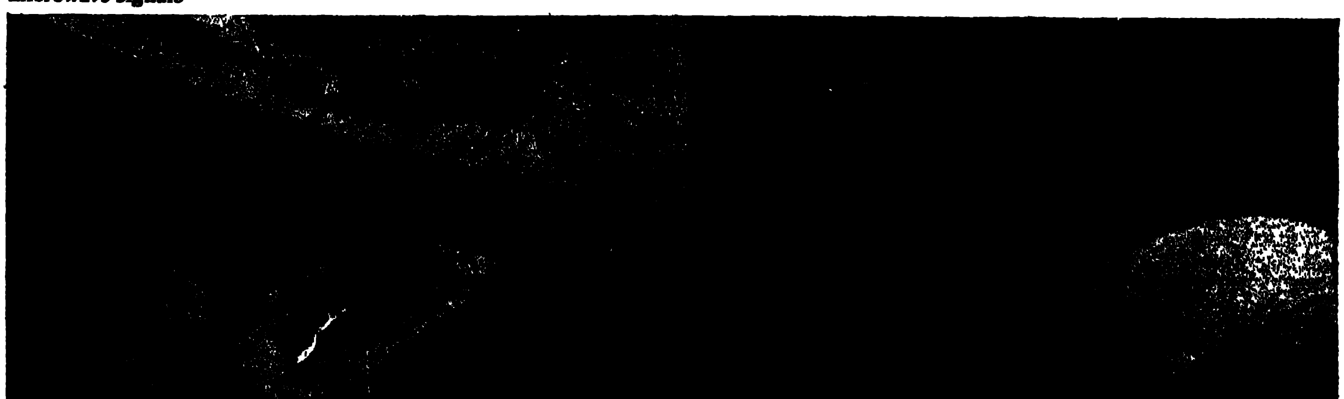
Once in space, the antenna will unfurl automatically, looking much like a huge umbrella

According to Mr. Garcia, a single antenna could provide coverage for the entire North American continent. If required, a second antenna could cover the South American continent at the same time.

Earlier, the company had designed and built the 9 m-diameter parabolic reflector antenna that was used on the National Aeronautic and Space Administration's Applications Technology Satellite (ATS)-6 during the mid-70s. That experimental communications satellite was used to relay health information to populations in remote areas of USA.

It was also repositioned over the Indian Ocean and used by the Indian government in an experiment to broadcast television programme to remote populations on the sub-continent.

Artist's impression of the 55 m-diametre antenna being launched from the Space Shuttle (left) and ready to receive and rebroadcast microwave signals



What is STEREOPHONIC SOUND

TWO-track, Stereophonic sound systems are well-known. But what exactly is Stereophonic sound? Does Stereophonic sound comprise of sound coming fro two different speakers? Well, not quite, there's more to it than meets the ears!

Let us begin with the physiological aspects of how we perceive sound. The microphones (mics) of our biological sound system are our two ears and as these are spaced apart, sound from a particular source arrives at different times (different phases) and with differing intensities at the two ears. The brain can perceive differences in the arrival time to the order of one millisecond—it assimilates the time difference between reception of the sound by the two ears and thereby estimates the direction of the sound. (This is somewhat similar to the way in which images formed at different depths in our two eyes is perceived by the brain to give the real position of the object. The existence of two eyes helps us to see the world in a three dimensional way. Similarly, the presence of two ears enables us to hear direction and depth of sound.) Besides arrival time differences, intensity variations caused by head-shadowing (our head physically blocking sound waves) also plays a part in localising the sound source. A Stereophonic sound system essentially simulates this characteristic of hearing with two ears. The importance of the two cues, that is arrival time cues and intensity cues vary according to frequency and is shown in the table below:

Frequency	*Dominating cue*
20 —700 Hz	Arrival time
700 — 2000 Hz	Both Arrival time and intensity.
Above 2000 Hz	Intensity

Thus it is obvious that the best way to record sound would be to do it in the same fashion as our ears pick it up. This could be done by placing two mics in the ears of a "dummy human figure" for recording purposes and listening to the recorded sound by means of a pair of identically spaced headphones. This is precisely what is done in the Binaural Stereophonic sound system and in ideal cases both the amplitude and phase of the sound waves incident on the dummy's ears are duplicated at the listener's ears. This method achieves the highest degree of realism—in fact the thuds of footsteps have been reproduced with striking similarity!

Headphones, however, are physically uncomfortable for long periods of listening and the method employed for Stereophonic recording and reproduction on two speakers is shown in Fig. I. The two mics in front of the ensemble of sound sources will receive sounds with different intensities and arrival times depending upon the spatial position of the source relative to each mic. When these separate sounds are reproduced by a pair of loud speakers the listener's brain is able to localise the sound in a manner similar to that in original space. The localising of sound in the listener's space constitutes what is known as the creation of 'Phantom Images'. The quality of Stereophonic sound, then, may be judged by its ability to provide cues necessary for the listener to perceive the location of the 'Phantom Images' with a pleasing overall effect.

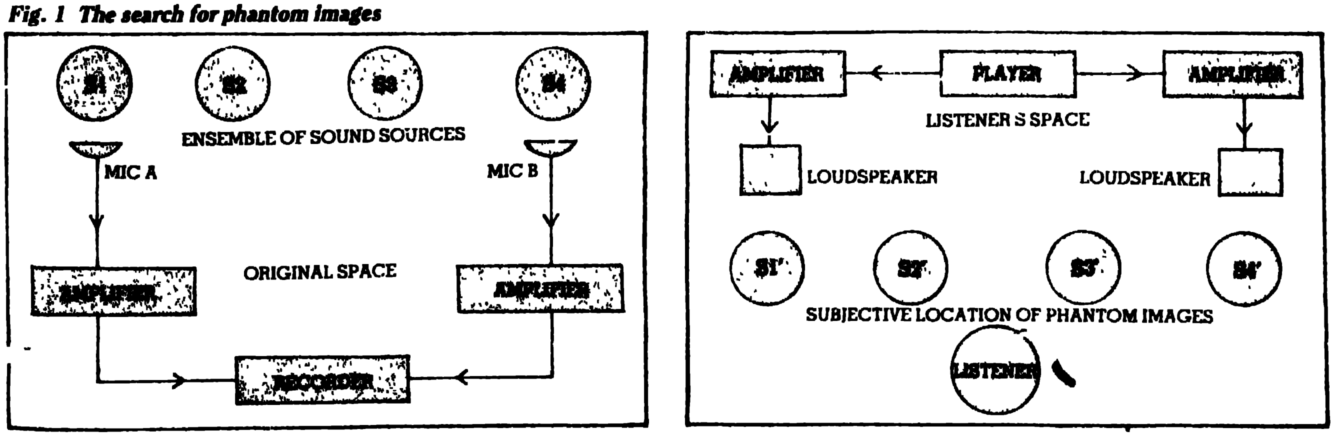
A highly enlarged view (left) of the two separate sound channels recorded in the stereo disc. The pattern of waves on the left wall carries the sound information for channel I while that on the right carries the information for channel II

The methods for Stereophonic sound recording or pickup can be abroadly classified into three techniques; Coincident, Spaced-apart and Individual-instrument.

The Coincident method employs two closely spaced recording mics, often in the same casing. Because of the close spacing, sound from a particular source will arrive at these two mics almost at the same time and therefore no arrival time cues can be used. However, because of the different positions of the various sources there will be differences in intensities of various sounds reaching the mics and this intensity variation is utilised for creating "Phantom imaging" A high degree of stereo imaging can be obtained by this method.

In the Spaced-apart method, the mics are kept several feet apart and both time and intensity cues are used. A problem with this type of recording is the tendenacy for the phantom images to concentrate at the two loudspeakers A mic in the centre, connected to both loudspeakers can help fill this void and is sometimes employed.

Fig. 1 The search for phantom images



In the Individual instrument technique each instrument or individual has a separate mic. The outputs from all these mics are fed into the two channels of stereo recording. What is exploited here is that a particular instrument could have a higher intensity in one channel so as to bring the phantom image closer to one speaker. When this is done for all the instruments, it is possible to provide the 'Phantom images' conforming to original space. Though this technique is rather involved, a large volume of music is recorded in this fashion.

So much for Stereophonic sound. How, generally, is this two channel information stored?

On magnetic tapes virtually two tracks are required to store the information. The orientation of the magnetic material on the tape contains the sound information. In the case of discs the process is more elegant. The sound information is stored in V shaped grooves engraved on the disc. The left wall of the groove is used to store the information for one channel and similarly the right wall for the other (See Fig. 2). As the stylus moves in the wavy groove, its vibrations are resolved into two perpendicular modes of vibration by the mechanism shown in Fig. 3. Each mode is picked up by a corresponding sensor, the electrical output from which is fed into one of the two speakers thereby reproducing the sound stored in one channel.

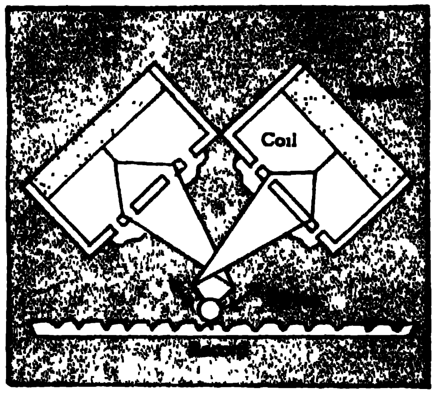


Fig. 3. Sectional view of a dynamic stereophonic/disk phonograph pickup

Many innovative strides have been taken over the last two decades to obtain higher degrees of fidelity. One such development is the Quadrophonic system which basically incorporates the use of four channels. However, due to relatively low costs and greater general compatibility Stereophonic systems are by far the most popular in the world today.

Kissan Joseph
Sanjay Kumar Shrivastava

The authors are students of the M.S. Physics Programme at the Indian Institute of Technology, New Delhi.

Continued from page 63

circumstances which are secondary to the person at the given moment. When he is indirectly involved

Let's say that the fly in the beer is not a joke, but a real situation, and it is your beer. You really want a drink, and are tired and irritable. It is hard to say how you might react to the waiter's joke, but people watching would laugh

In essence, laughter is always the result of looking at something from the side. Not all of us are capable of doing this or able to do it all the time There are people whose personalities are such that they are deeply immersed in one goal and rarely laugh. Then there are those who take nothing close to heart but laugh constantly. I won't take it upon myself to say which of them is the happier

S. You mentioned three conditions. What about the fourth?

P. The fourth we call *"a sense of humour'*.

S. I understand that laughter depends on positive emotions and can guess why laughter occurs infrequently. But let us return to Dostoyevsky's idea. How does laughter characterise a person's individuality?

P. Laughter reveals the multitude of man's needs. For this reason, it almost always has certain emotional nuances. I once found a long list of the different kinds of laughter in a book by a Soviet literary historian: kind, angry, proud, sincere, condescending, ingratiating, contemptuous, frightened, insolent, timid, unashamed, embarrassed, playful, sly, mocking, malicious, happy...There were over 30 entries. Laughter can even be sad, despondent or lifeless!

The author also included physiological and bestial laughter. It can arise from a complacent feeling of superiority of the given subject at the expense of well automatised habits. But laughter can be still more primitive when it is connected with the subconscious. It expresses only that the subject is experiencing physiological satisfaction and no more. In all probability, our prehistoric ancestors laughed like that.

But there is still another form of laughter Not simply a nuance, but a form. It is this form, in essence, that most clearly shows the need that lies at the heart of the feeling which gives rise to laughter—the need for knowledge. I think that it was this need that made man a man in the evolutionary process.

I am talking about pure, spontaneous laughter. We hear it very infrequently, but we recognise it immediately.

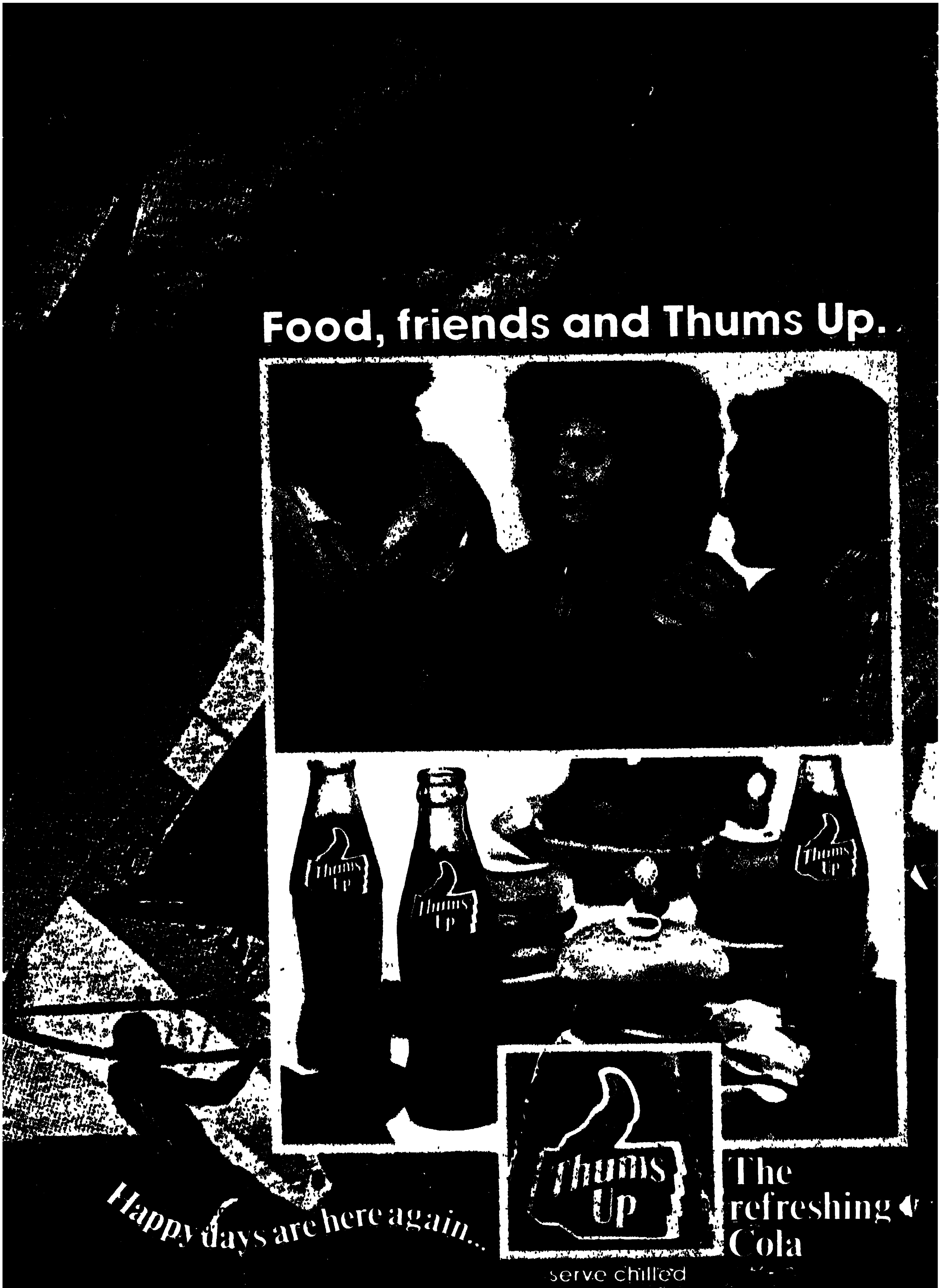
Pure laughter is the triumph of the person who wants to know over that which he wants to know, the joy of acquiring knowledge, of overcoming one's blindness and slow-wittedness. This kind of laughter bursts from a person at the moment of enlightenment. But enlightenment in such cases is unique: it comes without the effort one usually has to expend in order to understand.

I said that we hear pure laughter relatively infrequently. This is true among adults, but what about children?

A newborn baby does not smile. The first smile of a normal child under normal conditions of development appears at about the fifth or sixth week of life. Initially it signals to the parents that their child is full and healthy. But later, as we know, the intensive period of learning about the world begins and each new discovery is followed by laughter. The joy of life which children experience can be explained first and foremost by the fact that they are full of a need to learn and that this need is being satisfied with no particular effort on their part For this reason, it appears that children learn effortlessly and joyfully at first.

But gradually, the life of a young person grows more complex and other needs begin to exert an influence on this ideal desire for knowledge. Smiles and laughter take on nuances and different intonations. Depending on the situation and on what makes a person laugh, an alert observer—and Dostoyevsky was a sharp, sensitive man—can determine the character and soul of another individual. Have I answered your question? □

This is a dialogue between Prof. Pavel Simonov, Director of the Institute of Higher Nervous Activity and Neurophysiology of the USSR Academy of Sciences and one of his postgraduate students.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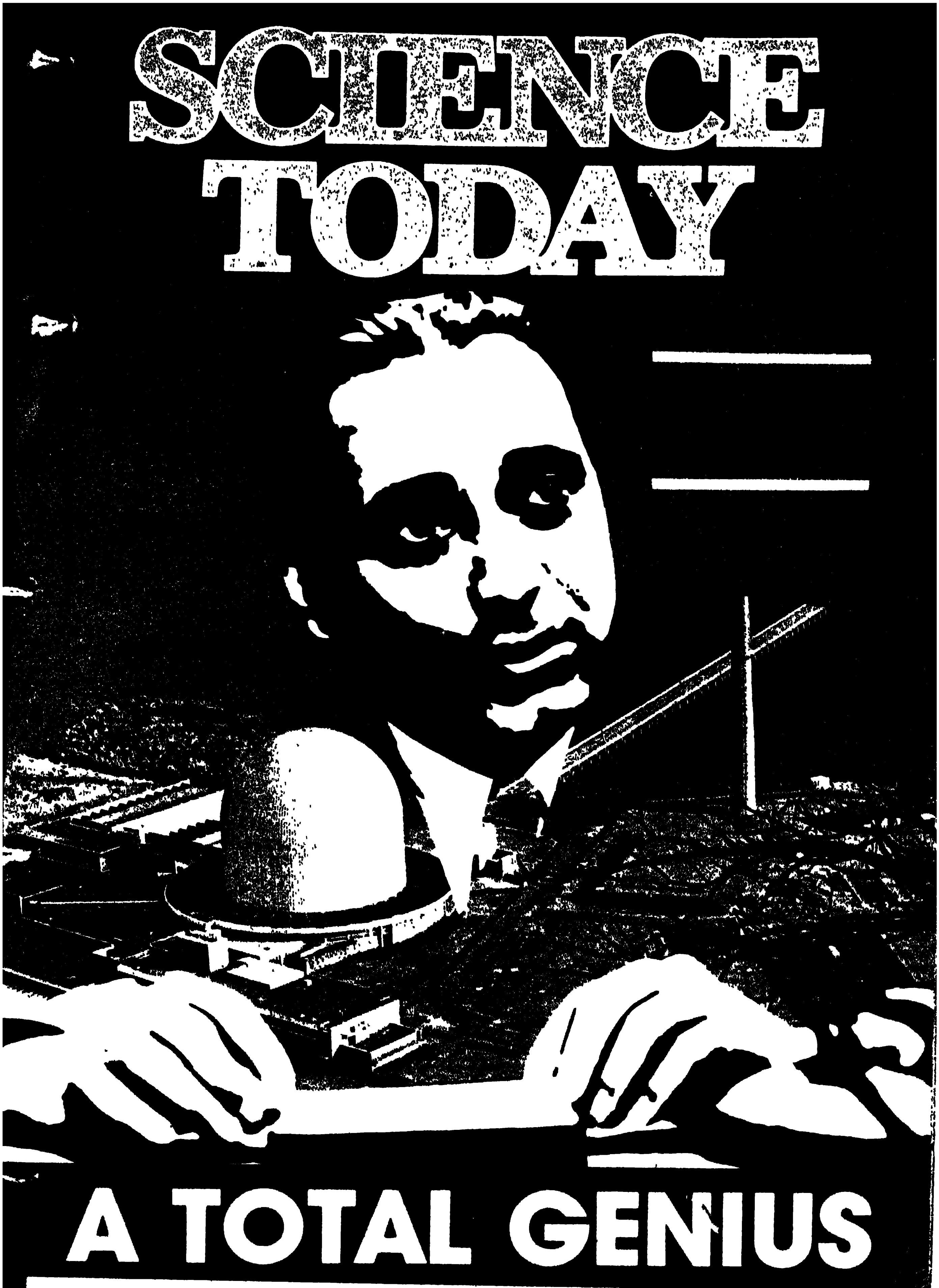
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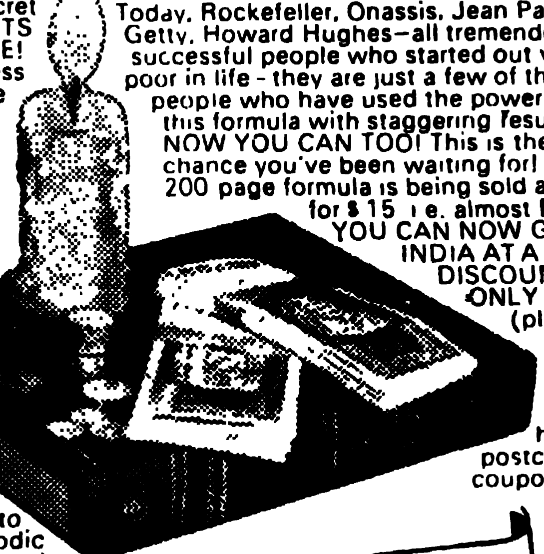

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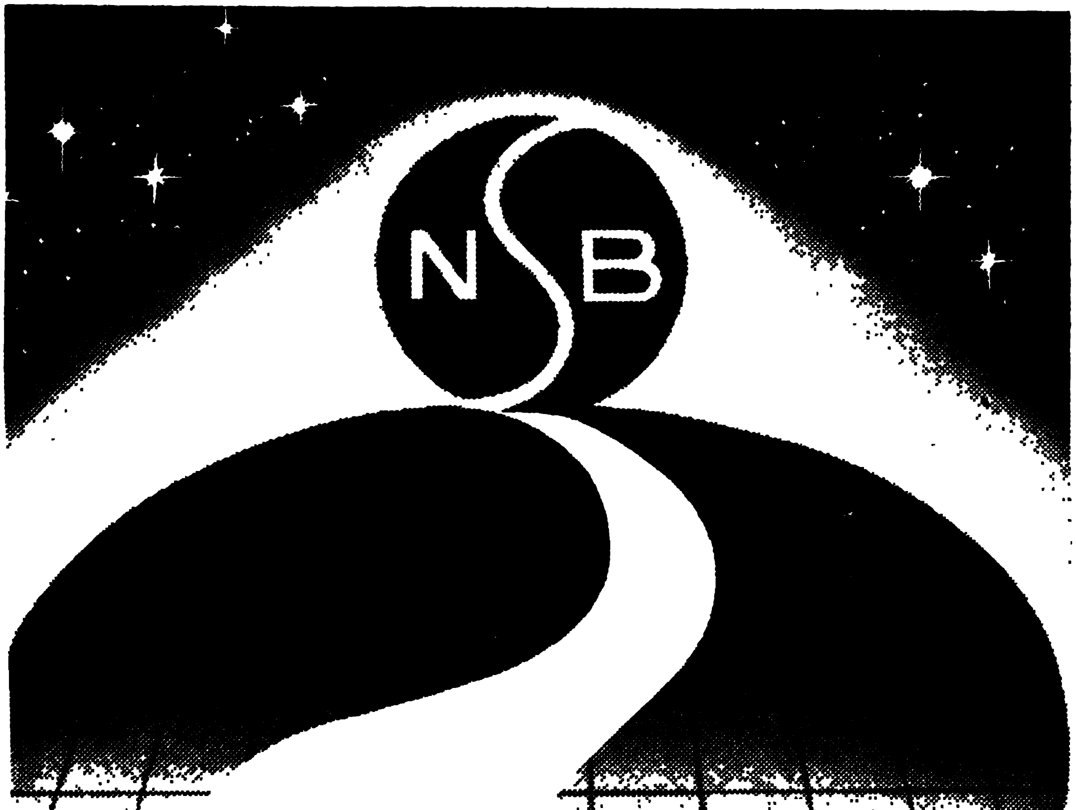
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SCIENCE TODAY
Vol. 18 No. 10
October 1984

A "universal" man

HOMI J Bhabha will be remembered among the more attractive personalities in the country's recent history There was something in him, apart from his eminence in science, that drew people towards him When one speaks of magnetism one applies the term to certain objects or certain political leaders But Bhabha was that rare being, a scientist with personal magnetism

He was an outstanding scientist, but he did not win the laurels that a few other Indian or Indian-born scientists have won The question will be asked: why did he not come to occupy a higher place than he did in the world of science especially when we consider that he was among the most gifted minds of his generations?

One of his teachers, C V. Raman, who, among his other distinctions, had a waspish tongue, often described as "carpetbaggers" those Indian scientists who sought opportunities and honours abroad Bhabha was not certainly one of them One could even claim that he sacrificed personal glory for his passion of promoting science in his country

Bhabha was a multi-faceted character, one who sought not only to unlock the mysteries of nature but one who adored nature in her various moods He brought to a degenerate India the sense of beauty and oneness with nature that once upon a time poets like Kalidasa possessed Bhabha loved beauty not of course in the crass sense in which many of us in an affluent urban society love it. Beauty to him was part of a way of life untinged by the vulgarities of today's commercial life. He was a painter of some merit and like most physicists, he was fond of music he had even an ear for Carnatic music He was, however, not a dilettante but one who shut out nothing from his life

His life's work was building the two great institutions, the TIFR and the Atomic Energy Establishment which later came to be called after him Had he confined himself to the laboratory he might have done work of sufficient importance to win him the Nobel Prize But he won something greater for his country, a place on the world map of nuclear science and atomic power. The tallest men and women in India's public life felt drawn to him, among them Jawaharlal Nehru He was what few scientists are, an inspirer of men.

Bhabha's death in an air-crash over the Alps in 1966 brought to an end a colourful career -- it was like a candle that illumined a whole area being extinguished in a storm However tragic his death, there was beauty in being lost in the snows and in mingling with nature "In art," said Bertrand Russell, "nothing worth doing can be done without genius, in science even a very moderate capacity can contribute to a supreme achievement." Homi J Bhabha was both an artist and a scientist Would it be excessive praise to call him a universal man?

R.G.K.

INDIA today boasts of the third largest pool of scientific and technical manpower in the world. This position has been largely achieved in 30-odd years since independence. The pre-independence era was marked by giants like Raman, Bose, Mahalanobis, Saha and others. However, their's were by and large individual efforts. Science in an organised fashion as is known today had not taken root then.

In no small measure this happy state of affairs is due to Homi Jehangir Bhabha. He was responsible for the establishment of the atomic energy programme and its offshoots which today constitute several independent departments.

If Bhabha had not met with that tragic aircrash on Mont Blanc in January 1966, and lived on, he would have been 75, come 30th October this year. And would he have been satisfied with the way science and technology have progressed and contributed to the nation's development?

Notwithstanding some of the doubting Thomases and carping Cassandras, we will only be deluding ourselves by not admitting the improvements in our economy in the last 30 years mainly due to contributions from science and technology. Agricultural output has risen almost five-fold and the gross industrial product has also registered a rise roughly of the same order From a country depicted as one with the begging bowl in its perennially outstretched arm we have now turned into potential exporters of food grains. Even our industrial export has crossed traditional barriers and broken new grounds of finished goods in heavy engineering products. Thus we can comfort ourselves with the thought that our technological ship is sailing merrily in untroubled waters.

Although Bhabha is best known for the introduction of nuclear power in the country, he never lost sight of the importance of fundamental research

However, storm clouds *are* gathering on the horizon. We can ignore them only at our peril. The best and the brightest of our young students tend to eschew fundamental science and queue up for applied sciences or technology. Bhabha would have been extremely worried about this. Although he is best known for the introduction of nuclear power in the country, he never lost sight of the importance of fundamental research. That, he believed, was the fountain-head to nourish self-reliance in technology.

It is gratifying to note that some of the leading scientists today are feeling concerned about the lack of motivation among the younger students to take up fundamental research. Two symposia held recently in Bombay, by the Indian Institute of Technology and the Marathi Vidnyan Parishad, addressed themselves to this grave problem. A sincere effort to set right the balance and to rededicate ourselves to the pursuit of pure sciences, we feel, would be the most fitting homage that can be paid to the memory of Bhabha.

EDITOR

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LIFE OBEYS THERMODYNAMICS

I read with interest the article "Physics and Darwin's theory" by Dr Murlidhar Tiwari (July 1984) but was unable to grasp the central idea of the write-up If the author feels that Darwin's theory has to be discarded in favour of the existence of a creator or a designer on the strength of the laws of physics, then I think he is mistaken He has suggested that living beings disobey the laws of thermodynamics, but this is simply not correct

It is true that the processes of joining smaller molecules into large polymeric ones involve an increase in free energy and cannot, therefore, take place spontaneously in living cells This led some people to believe that organisms possess a unique property of working against thermodynamics and this property was considered as the secret of life

It is, however, now realised that biosynthetic processes do *not* at all violate the laws of thermodynamics The mechanism of these reactions is now well understood The formation of a simple dipeptide from two amino acids involves a free energy change of 1 to 4 K Cal/mole The positive Δ G values apparently tell us that the polypeptide chain cannot form from free amino acids But these 'synthetic' reactions never take place in isolation They are always coupled with the breakdown of high energy bonds of certain biomolecules so that the net free energy change is always negative ATP (adenosine triphosphate) is such a molecule When a terminal phosphate group is broken off by reaction with water a large amount of free energy is released

In conclusion, I would like to say that if there are any arguments against Darwinism, thermodynamics is not one of them!

R M SATHE

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'Living matter is just the interplay of atoms, natural forces and radiation' This statement is as true as the one which says that a water molecule is formed from two atoms of hydrogen and an atom of oxygen Dr Tiwari's idea that living beings are designs contrived by a "Creator" leaning on thermodynamics for support does not seem to stand well The living system is in no way a closed and an ideal system to which physicists and chemists can apply their laws Every moment the energy content of various molecules involved undergoes change Whether we breathe or sigh, the change is there

Unlike any crystal, the living system is heterogeneous in content and open We will have to question ourselves of reasonability before deducing from the results obtained on application of physical and chemical laws on such a system It is an accepted fact (as all theories are accepted assumptions) that living systems cannot be considered separately at any level, be it a molecule like hemoglobin, an organ like the eye or an organism itself responding to its surroundings Thus it is easy to see the interplay of energy between the living system and its surroundings as a necessary condition The development and birth of an organism from a fertilised egg into a well organised form is a process of continuous change This process of differentiation is due to the interaction of the cell with its changing environment Even the like kind of cells are exchanging matter and energy among themselves

Evolution and the origin of life can be explained in similar terms Probably there would have been no cell if DNA, protein, amino acids and RNA after their formation had not interacted eons ago With their interactions they developed a more stable type of co-existence than their previous free forms Thus life and probably the code of inheritance evolved

Life, its origin and evolution is a continuous process, and too complex to understand with even the present state of knowledge However, we can say with confidence that life processes are continually in search of a more stable state at all levels of organisation *No doubt this complexity is perplexing to us since the methods of inquiry are simpler than what the situation demands* With more evidence from fields other than biology, we can hope to understand life as a physico-chemical process rather than hastily accord to it a special merit on this planet

A S K V S SHARMA

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Speak up, Indian scientists

I read with great interest the article 'Scientists: Prisoners of Conscience' by Wilfred D'Costa (July, 1984). It is heartening to note that there exists a big group of active top scientists who are committed to the cause of fighting out injustices meted out to some scientists by the establishment.

I am sure that any rational person would outrightly condemn the USSR for her beastly behaviour, in spite of her claims of promoting Marxism and the encouragement of science and technology.

Unfortunately the state of the scientists is very miserable in our country too. No group of active scientists will dare to come out in the open to support such injustice Of special note is the recent case of Prof. Dhirendra Sharma of the Jawaharlal Nehru University, New Delhi, who has been subjected to indirect harassment by the establishment for his criticism of the Department of Atomic Energy, its policies and management Why have no scientists taken up this issue? Neither has your esteemed journal reported on this case (although you seem to agree about the dire need of such a campaign as is explicit from your publication of the article of Wilfred D'Costa).

SUHAS B NAIKSATAM

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Sardarnagar No 4,
Sion (E), Bombay 400 037

ANNOUNCEMENTS

A two day symposium on "Use of Monoclonals in Biomedicine" will be organised at the Cancer Research Institute, Bombay 400 012 on 16th-17th November, 1984

Besides the invited speakers, a few observers would be admitted to the Symposium

A registration fee of Rs 150 will be charged for observers

For details, contact Research Director, Cancer Research Institute, Parel, Bombay 400 012

A National Symposium on Vacuum Technology and Sealed-off Devices will be organised on 19 to 21 December, 1984 at the Bhabha Atomic Research Centre, Bombay Those interested may please contact the undersigned

DEVAKI RAMANATHAN

Convener
IVS National Symposium '84,
C/o Technical Physics &
Prototype Engg Divn ,
BARC Bombay 400 085

Spiders in aid of doctors and farmers

SPIDERS can have their uses too! Research at Liverpool University, UK, on venom of a South American spider could lead to the production of drugs which can be used for the control of the human nervous system and even safer insecticides

Dr Robert Johnson of the organic chemistry department has already succeeded in isolating a pure toxin from this venom Plans are afoot to identify the molecular structure of this toxin and to synthesise it in the laboratory The synthetic, purified component can then be used to test its biological effects on the nervous systems, of both mammals and insects

The enhanced interest in spider venom is mostly because of its very unusual properties The venom can kill, as well as immobilise the prey over long periods, ranging from a few hours to a couple of weeks, at the same time the normal metabolism of the prey continues undisturbed This state of paralysis cannot be achieved in living systems over such extended periods without the system failing or completely degenerating "If a drug could be developed from the venom toxins, it might be possible to immobilise surgical patients more simply and for longer periods than at present", says Dr Johnson

Another possible use of the toxin will be in the development of new types of insecticides which would imitate the action of the spider venom and thus incapacitate the insects preying on crops

New magnets from rare earth compounds

A NEW rare earth magnetic compound has been discovered by independent research groups in USA and Japan In a recent meeting of the American Physical Society (APS) at Detroit, USA, the scientists discussed the structure of the new compound and theories explaining its unique magnetic properties

In 1978, the need for a new magnetic material was felt when the price of cobalt, the most widely used ingredient in permanent magnets, soared This was due to political instabilities in the south African countries where cobalt is produced

In 1983, the scientists discovered the new magnetic material, neodymium Magnets made from this new material will soon be put to diverse uses, ranging from stereo speakers, computer disc drives and printers to telecommunications General Motors, the largest consumer of permanent magnets in the world, plans to fabricate its own brand of the rare earth compound to replace the battery-driven electromagnets currently used in motors

Two properties are considered of paramount importance when constructing a new magnet· coercivity and energy product The coercivity is a measurement of how difficult it is to demagnetise a material with an external magnetic field. The coercivity multiplied by the maximum intrinsic magnetic field of the material gives the energy product – a property that is used most often as the yardstick for comparing materials in the magnetic race. The higher the energy product, the smaller the magnet required for a given application

Researchers agree that the compound with the highest energy product contains

"Confiscating my video? For heaven's sake! When I went that side they confiscated my mangoes "

Shiga bacillus: from West Bengal to Bristol

HERE we produce a letter from a recent issue of *Lancet* by Dr S D Williams and R C Groggins from the Children's Department, Southmead Hospital, Bristol, about the rapid intercontinental spread of *Shigella dysenteriae* type 1.

"The seven-year-old son of a healthy Bangladeshi restaurateur was admitted to hospital on 20 June, 1984 with a two-day history of colicky abdominal pain, fever, and profuse diarrhoea with blood and mucus in the stool He had never been abroad (outside UK), but the family were being visited by two cousins from Sylhet in northern Bangladesh, adjacent to West Bengal They were both well, with no gastrointestinal symptoms The patient's stool was cultured and grew *Sh dysenteriae* type 1, sensitive to nalidixic acid, gentamicin and ampicillin but resistant to tetracycline, co-trimoxazole, and chloramphenicol The diarrhoea gradually settled with nalidixic acid

The immediate family, including the two relatives from Bangladesh were screened for *Shigella* infection No positive stool culture was obtained On questioning it was discovered that the cousins had imported cheese, mangoes, and fresh vegetables for consumption by the family None of these items were available for examination but we believe contaminated food to be the probable source of infection Routine public health measures to avoid spread via the local *tandoori* restaurant were instituted and no further cases appeared "

This case yet again illustrates the speed with which rare infections, even from remote areas, may spread assisted by modern air travel This is specially likely to occur in those cases with close family ties in epidemic areas.

a rare earth (R), iron (Fe) and boron (B) in the phase $R_2Fe_{14}B$. While many rare earths can form this phase, only neodymium and praseodymium have been shown to result in high energy products

The world's coldest insect

JAPANESE entomologists have discovered a new species of cold-tolerant midge in a high-altitude glacier in the Nepal Himalayas. Reporting the discovery in *Nature*, Shiro Kohshima says the adult insect (Chiromidac, Diamesa Meigan sp.) has reduced wings and antennae, it is unable to fly and is generally found walking on the surface of the glacier and in small cavities beneath it. Almost all adults found on the surface of the glacier were females which appeared to be able to orient themselves by means of a Sun compass. They walked in straight lines the direction of which could be altered by changing the apparent position of the Sun with a hand mirror. All copulating pairs and adult males were found on the ablation surface beneath the snow surface; indeed, the males seem to spend their entire lives there. The insect is thus the first to be found which spends its entire life cycle in the coldest insect habitat ever recorded (it was active at temperatures as low as -16^0C, well below those at which activity was seen in insects living in other old habitats including Antarctic ones). The study also discovered a previously unsuspected ecosystem based on algae and bacteria growing in ice: the larvae of this unique chironomid lived in the melt-water drainage systems along the ablation surfaces and fed on blue-green algae of *Phormidium* sp. These insects also displayed exceptionally long life spans (one month) by chironomid standards. Most chironomids have very short adult period and they tide over the winter in the larval stage. However, this Himalayan species seems to spend the winter in the adult state (without feeding) and deposits its eggs in the melt water channels in the next spring. The obvious advantage thus gained is that the larvae are assured of food in the melt-water channels which cannot be predicted in the previous winter, especially in a changeable system like glaciers

Worth the salt?

ARE you diet-conscious? If you are, then do you ever keep a record of how much salt you consume in a single day? The physiology of our body requires a certain amount of salt or sodium chloride. In order to replace the amount of sodium which is lost in urine and sweat, salt intake is essential. Our body requires about half a gram of salt. However, each individual consumes about six to 24 gm every day.

It has been suspected that salt raises the blood pressure leading to cerebral strokes or heart attacks. Hypertensive patients have high salt concentrations in their bodies. This may be a consequence and not the cause as hypertension can be inherited. For people who have a tendency to inherit hypertension, two theories as to how sodium interferes with blood pressure have been put forward.

The first theory is based on the inability of getting rid of extra salt. To compensate, kidneys leave more water in the blood thus increasing the blood volume which raises the blood pressure.

The second theory describes an unknown substance, a sodium regulator which tries to compensate for the high intake of sodium from the diet. The substance acts on body tissues and blood vessel walls, accumulating sodium. A high sodium concentration draws calcium, causing calcification which contracts the muscles. As the blood vessel walls contract, the blood pressure rises. This rise in blood pressure can be overcome by giving these hypertensive patients low salt diets according to Graham MacGregor of Charing Cross Hospital, London. However, there were others who found that this was not true. Also, David McCarron of Oregon Health Sciences University, suggested that sodium has nothing to do with high blood pressure. Instead, it is the lack of calcium and potassium which causes the rise in the blood pressure.

In the light of these reports, it is still not clear whether it is safer to eat less salt. Animal experiments have revealed that sodium restriction damages kidneys, stunts growth and increases the susceptibility to the effects of haemorrhage. Recently in Britain, the Faculty of Community Medicine, Royal College of General Physicians, is considering whether to release a report which supports a campaign to reduce salt consumption

Why women athletes are supple and skinny

DID you wonder why highly trained women athletes have a supple and skinny body frame? Well, scientists have come up with an answer to the riddle. Decreased bone mass, that's what it is. But what is the reason for this reduction?

Quite a few of these athletes are known to have significantly reduced levels of menstruation. Twenty-five to 40 per cent report fewer than three

menses per year. This secondary amenorrhea leads to low levels of the female sex hormone—estrogen

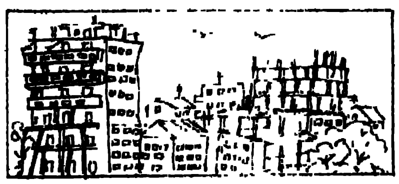
Recently, Barbara Drinkwater with her colleagues in the UK compared these amenorrhic athletes with eumenorrhic (normal menstrual cycles) women athletes and matched them for age, height, weight, sport and training regimens. The dietary history of these two groups of athletes showed no differences in nutritional intake. Both had the same percentage of body fat and yet the first group showed distinctly reduced bone mass. This was measured by looking at the bones in the spine (lumbar vertebrae) as well as the sites of the arm bone (radius). This reduction, according to their finding, is due to the low levels of estrogen.

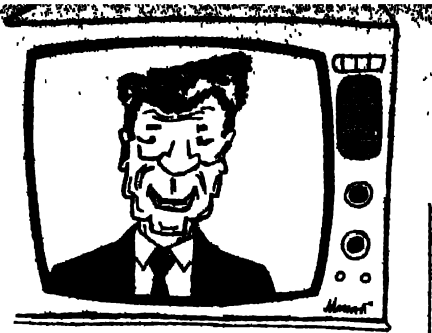
That still leaves one question unanswered though. What prevents the super women athletes from Russia and the eastern bloc countries from acquiring that lean, hungry look?

Unsafe buildings—here, there, everywhere

WE have highlighted the poor quality of building materials (see SCIENCE TODAY, June 1984) used for putting up structures in India. This, however, is not limited to our country alone and seems to be a global phenomenon. The Ronan Point tower in London has been notified structurally unsafe after it failed a fire test recently. Its floor slabs which should have lasted for 20 minutes deflected and cracked within 12 minutes the duration for which the blaze lasted.

The south east corner of Ronan Point had collapsed after an explosion in 1968. Four people were killed and 17 injured in the incident. Repair work was completed immediately and the building was declared safe. However, in April this year, gaps of five to 60mm were discovered between cladding panels. The fire test further revealed the vulnerability of the building.





"This Teflon coating is good! That's why I can't stick 'em Russians, I can't stick 'em disarmament, I can't stick 'em anybody fooling around in Grenada."

Teflon presidency?

MANY things are said and will be said about Ronald Reagan, the President of the United States of America. But the latest quote coined for Reagan's presidency term is "the Teflon presidency" by Congresswoman Pat Schroeder in the *Daily Mail*. This is because of his capacity to survive bad news without anything sticking.

Du Pont, the makers of Teflon, has jokingly warned that 'this is a trademark-misuse and the term "the Teflon Flourocarbon Resin presidency" should be used instead.

Forgotten man of science

PROFESSOR Sridhar Sarvottam Joshi, one of the well-known chemists of our country, after whose name a scientific effect has been named, died recently.

Professor Joshi was born on 16th October, 1898 and was educated at Banaras obtaining his M. Sc. degree and subsequently at London where he obtained the D.Sc. in chemistry. He was the University Professor and the Head of the Department of Chemistry and the Principal of the College of Science of the Banaras Hindu University. Professor Joshi was fellow of the Royal Institute of Chemistry, of the National Institute and of the Association of Science, India. He was President of the Chemistry Section of the Indian Science Congress in 1943.

Professor Joshi has made significant original contributions in colloids, electrochemistry and discovered a new effect of light, which was known as "Joshi Effect". In simple terms, Joshi Effect, which he politely called only a light effect, is a fall or rise in the low-frequency alternating current passing through a gas dielectric condensor when the gas is irradiated and continuously with visible light. The fall and the rise in the current are known as a negative and positive effect respectively. For this interesting experiment, he and his co-workers used annular type Siemen's ozonizers with the inside wall coated. This phenomenon yields a corona or 'silent' discharge to be distinguished from the 'dark' discharge obtained between disc-like metallic electrodes and is distinctly different from negative photoelectric effect. The method based on this effect was used for the activation of gases like nitrogen. Based on these results, Professor Joshi published over 150 papers in national and international journals which were acclaimed all over the world.

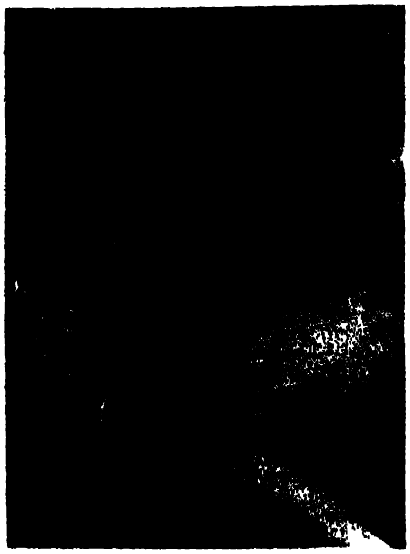
Professor Joshi was married to Miss Sontara Chiplonkar and had a son and a daughter. Cricket was his recreation.

In the sad demise of Professor Joshi the Indian scientific community has lost a pioneer amongst the scientists who used light as a source for experimentation.

M.A. Nabar

BLOOD PRESSURE AND NUTRIENT INTAKE

Deficiencies, and not excesses, of a nutrient item cause hypertension in individuals



HIGH blood pressure has assumed almost epidemic proportions in all 'civilised' communities of the world and India is fast joining the ranks, especially as far as the urban population is concerned. Roughly one in every 10 persons is found to have hypertension This subject has, therefore, become a topic of intense research

It is a well-known fact that diet plays a role in control of hypertension The relationship between salt-intake and hypertension is now well established by epidemiological studies However, a planned study of the relationship of various dietary components (nutrients) and hypertension is not well studied

Now David Mc Carron and his associates from the Oregon Health Sciences University, Portland, USA, have published a provocative study in a recent issue of *Science* (**224** 1392) regarding the relationship levels of various nutrients in diet to the incidence of hypertension They analysed data collected by the National Centre for Health Statistics from healthy subjects in a statistically adequate and scientifically designed and representative sample of noninstitutionalised American population (10,372 individuals) above the age of 18 years

Proportions of various nutrients in their diets were determined from known concentrations of these nutrients in normally consumed articles of food The various nutrients studied were calories, proteins, fats, carbohydrates, phosphorus, sodium, potassium, vitamins A and C, saturated fat and cholesterol. Three different definitions of hypertension were utilised and data were submitted to statistical analysis by various methods to eliminate the possibility of a chance correlation

It was found that hypertensive persons had a significantly decreased intake of calcium, potassium, vitamins A and C as compared to the control (normotensive) group The relationship of calcium-intake was found to show strongest negative correlation Regarding the relationship of vitamins A and C, it was felt by the researchers that this could be a coincidental finding as these vitamins occurred in natural combination in foods with higher concentrations of calcium and potassium respectively

These findings, however, suffer from a few drawbacks The diet survey is based on histories of diet-intake for one 24-hour period Though admittedly it is difficult to have a more reliable method of survey, it is more than likely that there is a great variation in food-intake of same persons during different periods of a year and over the period of years as he or she grows up It is also interesting to note that a similar negative but statistically insignificant correlation between hypertension and intake of fats, saturated fats, carbohydrates and calories is also shown

Summarising, the present survey suggested the following:

(1) There are predictable nutritional differences between individuals with high blood pressure and those with low blood pressure, (2) It is the deficiencies and not the excesses of a particular nutrient that characterise the hypertensive individual, (3) Reduced consumption of calcium and potassium is the primary nutritional marker of hypertension, with accompanying reductions in vitamin A and vitamin C, (4) Dairy products are the food group for which reduced consumption is most closely related to high blood pressure; (5) These observations are largely independent of age, sex, body mass index, and alcohol consumption, and (6) Diets low in sodium are associated with higher blood pressures, while high-sodium diets are associated with the lowest blood pressures

However, a word of caution. Clinical use of sodium or cholesterol-restricted diets for patients with high blood pressure or cardiovascular disease must be monitored closely to avoid inadvertent and simultaneous reduction in calcium and potassium intakes below current recommended daily allowances. These data then raise the important question of sodium restriction as a routine in several hypertensives Here, the identified "salt-sensitive" patients and patients with compromised cardiac or renal functions are the obvious exceptions

The results obviously point to a new direction in our attempt to reduce or prevent the occurrence of hypertension in general population, rather than treating it after it has already set in A prospective study of the incidence of hypertension in a population sample put on a diet containing higher concentrations of calcium and potassium, as compared to that in suitable controls, is also worthwhile to further clarify the significance of the above conclusions

In India the dietary habits are much more diverse than in western society and hence the above findings cannot be extrapolated to our surroundings. No documented study of a similar type has been conducted here.

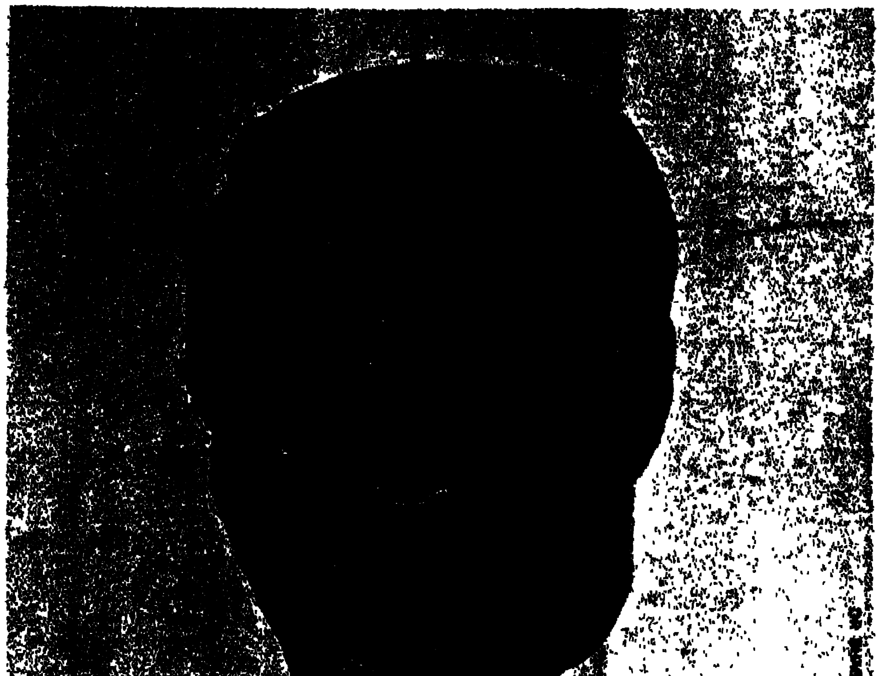
P.A. Kale

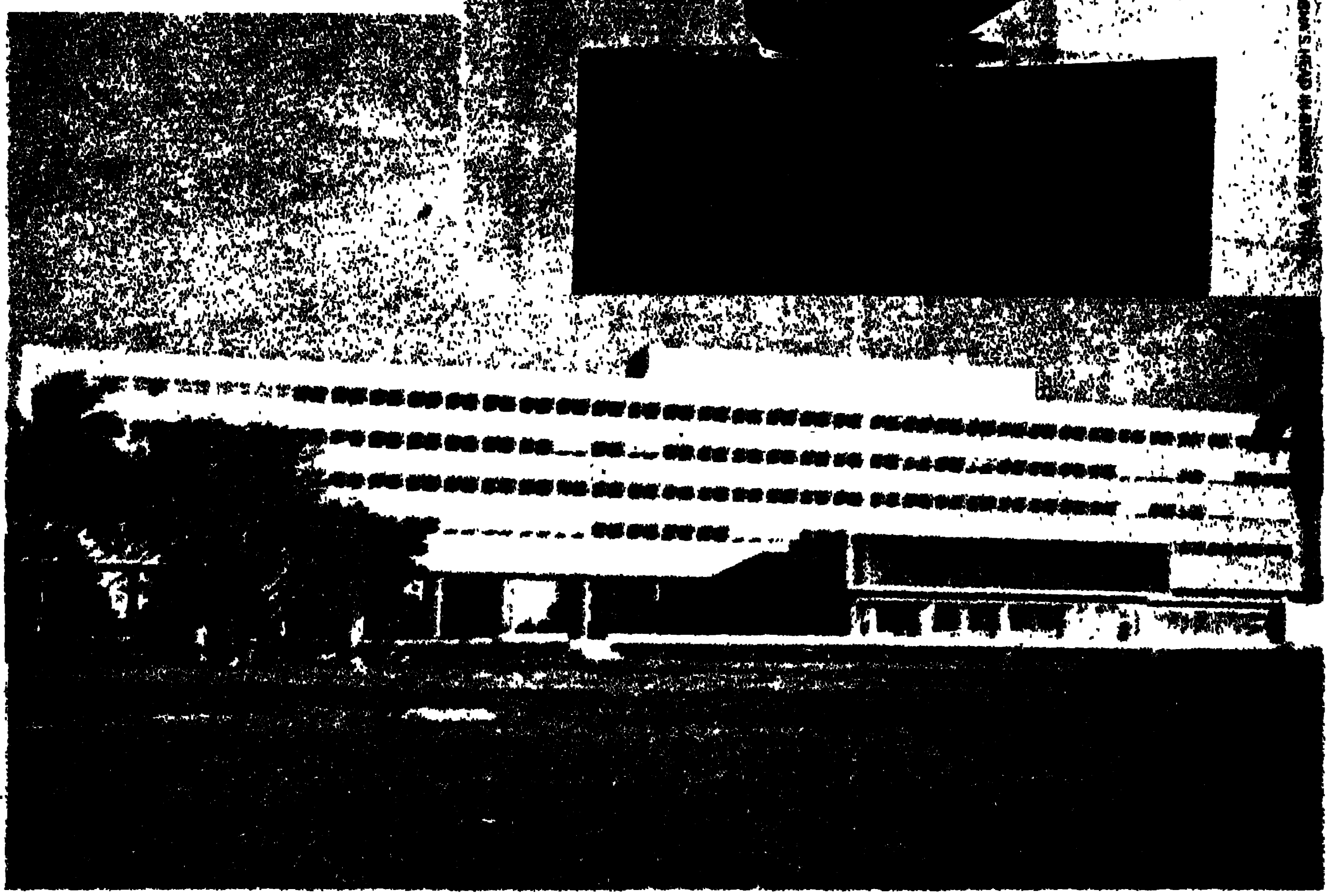
Dr Kale is Honorary Professor of Medicine at the Seth G S Medical College and KEM Hospital, Bombay

Founding Fundamental Research

Bernard Peters

HOMI Bhabha was a man with a versatile personality with many facets. He drew inspiration from his favourite guide Leonardo da Vinci and like him, he tried to develop all his many talents simultaneously to the fullest possible limit He became known beyond India's borders as a mathematical physicist, creator of the Indian Atomic Energy Programme, initiator of a modern electronic industry in India, one of the main architect of the International Atomic Energy Agency, the president of the first United Nations Conference on Nuclear Energy for Peaceful Purposes etc However, less well known outside India, were his other activities which took up much of his time and attention He was a Maecenas of Indian painting and a painter in his own right, a designer of





With Professors Einstein, Yukawa and Wheeler at Princeton in 1947

buildings and gardens, a successful and innovative administrator who adopted existing government practices to the requirements of large modern research facilities, the architect of the Indian government's science policy with its strong tradition of support for fundamental research and much more

There was yet more to Homi Bhabha's personality One could have informative and substantial discussions with him on such diverse topics as philosophy, medical research, population policy, music, or contemporary and classical art However, the facet which I know best is, Dr Bhabha, the founder and first director of the Tata Institute of Fundamental Research (TIFR)

I joined him at the Institute when it still was a small, poorly equipped skeleton organisation, engaged in a narrow area of research and housed inadequately in unsuitable premises I have seen the institute grow in Bhabha's lifetime, into a large, well housed, well equipped and well staffed organisation, that even scientifically advanced countries would be proud of.

How did Bhabha succeed in creating in India, a scientific institute which acquired renown within a few years after its start, which survived its founder and retained its vitality for decades after his premature death? There are of course numerous reasons for this success, all of them necessary, none of them sufficient Out of these, the reason which I consider the most important one is the choice of the initial field of concentration of research and the methods used for adapting and broadening the research programme in the light of advances in science and the growning competence and technical abilities of the institute's staff. But before discussing this in detail, it is essential to mention a number of innovative policies, which Bhabha introduced, that contributed much to his success.

There was to be no discrimination on the basis of case, race, religion or sex at the new institute, an important and radical departure from age-old traditions in India This policy permitted to recruit talented young people from all parts of India It also had the important effect of dissolving the prejudices which many of the young recruits brought with them from home, and it taught them to judge their colleagues and others primarily on the basis of character and ability. The common-lunch facilities at the institute, open to clerks and professors alike, played an important role in creating the comradely atmosphere characteristic of all successful modern institutes.

The selection of new academic staff was done with great care. School or college grades of an applicant did not form an adequate basis because of the large differences in standards at various schools and universities Initial selection was based mainly on a paper in which the applicant described his interests inside and outside of science and his reason for choosing fundamental research as a career The subsequent interviews often involved hundreds of applicants from all over India and centered more on ability to think and scientific creativity rather than on book-learning. Successful candidates received a stipend to attend advanced courses at the institute in modern physics, chemistry, mathematics etc. Final selection was based on their performance in these courses.

Promotion of the staff was based on scientific and technical merit and not on seniority, as it was and still is prevalent in many places.

Free flow of information within the institute was promoted through numerous specialised and general colloquia. Secrecy in research whether for industrial, military or personal reasons had no place General colloquia by outstanding scientists from East and West were arranged frequently and would cover a wide range of subjects, not necessasry related to the subjects of research at the institute.

A further important element in creating a lively intellectual atmosphere was Bhabha's effort to broaden the intellectual base and widen the range of interests of the staff For this purpose the institute library acquired books and subscribed to journals covering various aspects of human culture; in particular all branches of the arts and sciences were represented and the staff (not only the academic staff) was encouraged to use the library. For the same reason original works of art, ancient and modern, were placed throughout the building and the institute played at times host to artists of highest quality (theatre, music or dance) with free access of the staff.

Scientists had the opportunity of visiting foreign research centres and were encouraged to present their results at international congresses provided they could satisfy the standard of excellence, which became current at the institute.

Finally, Bhabha was aware of the need for improving the economic and housing conditions for the staff. His institute was one of the first in India, which provided health insurance and care to all, including workmen and their families.

These policies created an environment, which promoted hard work and devotion and which at times became quite buoyant and adventurous, once the scientists discovered their ability

India was a particularly favourable place to study what Bhabha felt was likely to be the focal point of scientific interest in the 'fifties

to make original and valuable contributions to contemporary science.

For an individual a passion to explore nature and to understand more than what is already known of its marvellous complexity and beauty, may be a sufficiently strong reason to devote all his life and major efforts to research. The purpose of organising a research institute however, has to go beyond that, and cannot be confined to providing opportunities for gifted scientists to follow their avocations Society expects to derive some benefits from the economic support, which it is asked to provide, especially in those countries, where the demands for the support of science have to compete with other urgent claims on the country's resources.

It is evident, that enormous material benefits have been derived in the past and can be derived in the future from fundamental research into the workings of nature, quite incommensurate with the sums that have to be expended on it. One needs only to think of medical research into the causes and cures of disease, of mathematics, mechanics and plant research for the increase of productivity of labour and agriculture, of the role which the understanding of the behaviour of atomic electrons have played in producing electricity for power distribution, home lighting, communication, etc

It is sometimes difficult to convince governments that the two purposes of research, namely to promote fundamental knowledge and to benefit society as a whole are neither incompatible nor independent But, in fact they coincide, provided that the quality of research is high The men and women who learn to uncover new evidence from experiments, learn to draw from it valid conclusions about hitherto unknown connections between natural phenomena Also, those who employ, improve and invent new powerful measuring instruments or those who produce in the laboratory higher (or lower) temperatures or concentrations of pressure and energy that have never been observed on earth, alongwith their scientific and technical assistants, are better equipped to contribute to its material advance than any other group in society Given the appropriate political conditions they are capable of setting up new industries, especially high-tech industries, health or communication services, rural centres for increasing agricultural yields, and performing other necessary tasks

Thus, it was an important decision taken by Bhabha, when India became independent, to first set up a competent institute, not primarily for applied research or engineering, but for fundamental research with a strong initial emphasis on mathematics and experimental physics.

Throughout his life Bhabha was fascinated by the processes in which (according to Einstein's famous formula $E = mc^2$) energy is converted into matter and matter into energy At that time the only process which was known was the creation of electron positron pairs by gamma-rays and the mutual annihilation of such a pair into two gamma-rays The process had first been observed in cosmic rays. According to Pierre-Victor Auger some of the incoming particles were energetic enough to produce in the atmosphere millions of electron positron pairs, which then reach the surface of the earth at the same instant Bhabha's most important theoretical work as a physicist dealt with this pair production phenomenon and the so called air showers which Auger had discovered Bhabha realised that at such high energies also heavier particles such as protons and neutrons are likely to be created and perhaps even other, as yet unknown forms of matter. Thus, in the nineteen forties, he concluded that high energy cosmic rays would soon be in the forefront of physical research, as indeed they were in the fifties. Many a novel phenomena especially a large number of new subatomic particles discovered, later led to the prodigious and expensive efforts of creating cosmic rays in the laboratory by building larger particle accelerators But until then, even a country with moderate resources could participate in many such important discoveries This was particularly true of India because of the geographic and other reasons:

Launching a balloon for cosmic ray research. India was the second country in the world which, before the Sputnik, could make extensive measurements 30 km above the Earth

1 India lies near the equator, where the terrestrial magnetic field shields the earth from most incident particles, such that only the highest energy particles can penetrate to its surface. Thus the equatorial region is best suited for studying the high energy cosmic ray component under conditions where the strong low energy background is eliminated

2 India has the highest mountain ranges in the world where cosmic rays can be studied in the rarified upper part of the atmosphere

3 India has in the Kolar gold fields, the deepest man-made hole in the ground, where some of the highest energy particles can be studied after they have traversed the atmosphere and several kilometers of rock

Hence, India was a particularly favourable place to study what Bhabha felt was likely to be the focal point of scientific interest in the fifties Furthermore, relatively inexpensive techniques also existed in this advanced research field such as Geiger counters which could be produced at home by a skilled glass blower, nuclear emulsion detectors, which were relatively inexpensive, and which were greatly improved in India, such that Indian detection techniques were adopted in laboratories all over the world There were plastic balloons to carry such

Continued on page 25

For Whom The Trees Grieve

S.D. Vaidya

DR Homi Bhabha was not only a scientist but an accomplished artist in his own right. His sensitive mind perceived the trees as living sculptures, giving a character of their own to the place where they stood ungrudgingly for generations. He was so much concerned about the trees that he must have been thinking about them even when he met with his tragic end on Mont Blanc in a plane crash

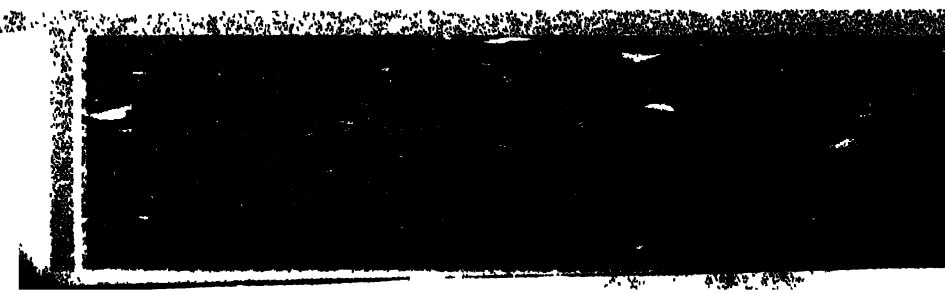
Dr. Bhabha was very meticulous about acquiring scenic sites for his nuclear establishments He saw that the sites had, in addition to technical and scientific requirements, potential for natural aesthetic developments While choosing the barren hills having strategic importance in Trombay for the Atomic Energy Establishment he was sure that the site could be afforested very easily

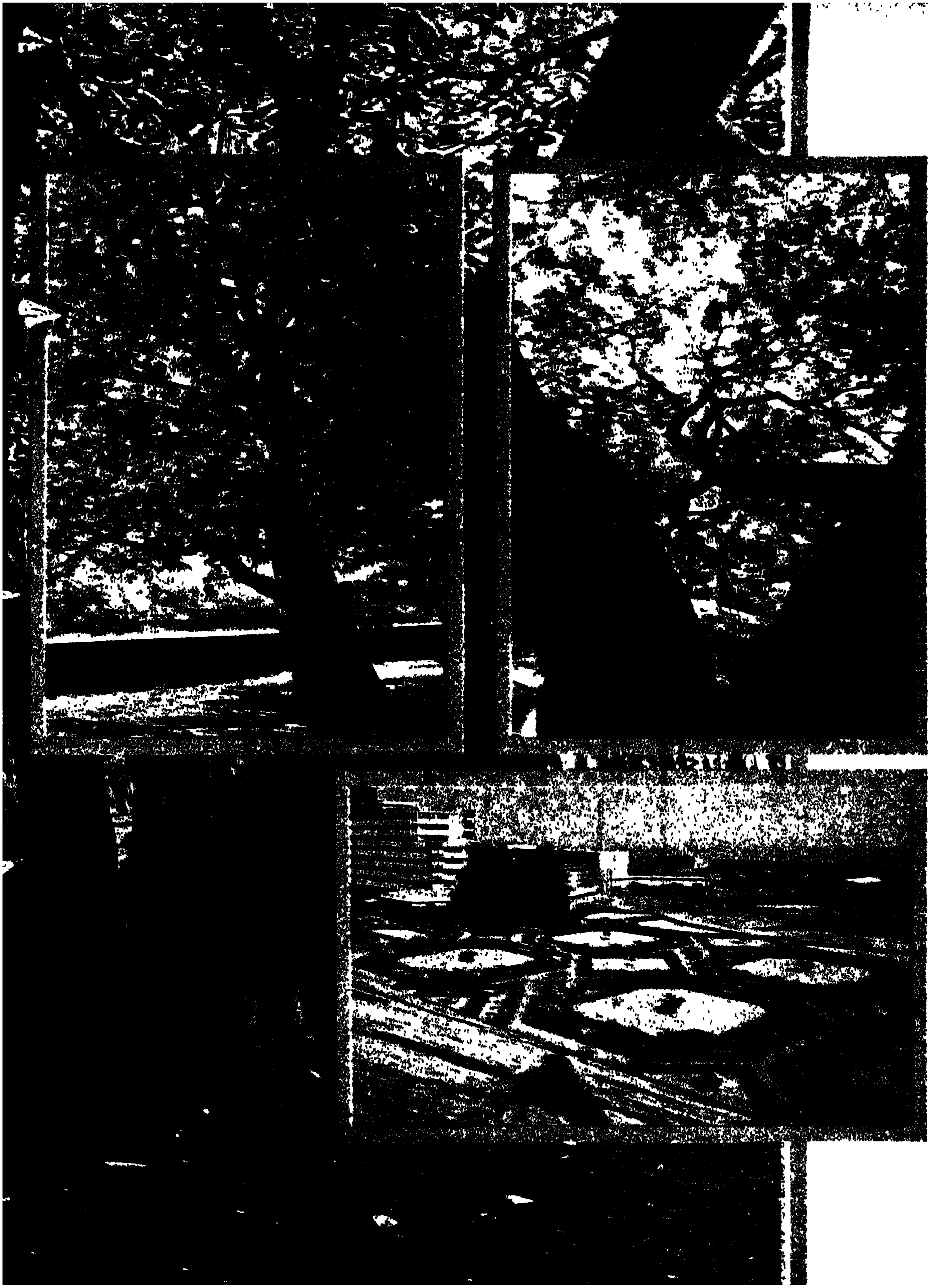
The Trombay hill was not long ago a very thickly wooded area, the vegetation thereon was completely devastated by indiscriminate cutting Dr Bhabha rightly gave top priority to the afforestation programme in the development of this project A plan for planting over a million and a half trees was drawn up to cover all the barren portions of the hill This was also completed on a task force basis The work of tree planting was carried out before the erection of the main laboratories and for that Dr Bhabha was criticised for giving priorities to aesthetics But his explanation was that the trees take their own time to grow The speed of construction of the concrete structures can be augmented artificially but the growth of trees cannot be hastened in the same way Early planting of trees was done only to gain on time

Dr Bhabha never considered landscaping as a luxury He always held that the garden was an essential component of site development in any establishment to lift up the spirit of the workers. In nuclear laboratories where scientists work for hours together it was all the more necessary to provide aesthetically pleasing surroundings for the workers Dr Bhabha, after his long strenuous hours of work in Trombay, used to stroll in the gardens for a few minutes to relax and to relieve himself of the physical and mental stresses After getting refreshed he would start working again for still longer hours, losing completely the sense of time

He always emphasised that in addition to providing aesthetic surroundings, gardens were functionally required by the nuclear establishments which housed a number of sophisticated electronic equipments Such establishments needed air-conditioned laboratories necessitating relatively dust-free surroundings Dust levels are always low in areas covered

PHOTOGRAPHS BY S N KULKARNI





We present a set of letters which Dr. Bhabha wrote to Mr. Vaidya explaining the designs of well-laid gardens in Europe

For Dr Patell & Vaidya

VILLA SERBELLONI BELLAGIO

Hermitte: near of the Walter garden in the Villa, there 1 [illegible] alley. The tongues are 20' to 40' wide. The vertical wall of [illegible] covered in some creeper. Terrace completely covered in some creeper. The topiary of different [illegible]. The hedges are of box. ~~[illegible]~~ They have very types of yew. THUJA ORIENTALIS. [illegible] narrow hedges of [illegible] — The narrow walls [illegible]. We shall try this for hedges — leading from one terrace to another.

Ediz. Fotocolor
023 SANDRO LANFRANCONI - Bellagio - Tel. 177

PHOTO VERITABLE

The rose garden in the Bagatelle. A rose bush in a scraggy bush, in a rose garden looks pretty scraggy when not in flower. Here the rose garden has been made to look beautiful and orderly at all times by the geometry of the planning. The geometrical shapes of the lawns are accentuated by low box hedges. The rose bushes are alternated by standards, 4' high. In the central lawn the standards are 6' high and then at regular [illegible] the roses are made to creep onto wooden frames 10' high. In addition, clipped box, cypress, or other [illegible]

EDITIONS de LUXE • ESTEL P. Reproduction interdite

ROMACOLOR

S 115

VILLA SERBELLONI
BELLAGIO
LAGO DI COMO

the central strip has pines of full height, but at a height of some 10' to 15' there is [illegible] bell/ball shaped [illegible]. I could [illegible] on either side [illegible] or [illegible]. This is an idea worth thinking of.

B →

In the Terrace Garden

Grass ////
Path
Grass ///

trees & benches

PHOTO VERITABLE

PARC DE BAGATELLE
Le Chateau et la Pièce des Nénuphars

View of the Bagatelle over the lotus pond. The lotus pond here beyond to perfection [illegible] shown on 1, which [illegible] a path next to the building, [illegible] the eye from a formal to semi formal garden, & then into an informal park.

HJB

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84 Rue Lecourbe PARIS-XV

ROMACOLOR

S 255

FC

Dr. Bhabha felt that the old mango tree which had lived (at Trombay) for over 100 years had every right to continue to stay in the same spot!

with grass or trees. Planned landscaping further helps to create a microclimate which brings down the temperature and lessens the load on the air-conditioning facilities

Industrial Versailles of Bombay

Dr. Bhabha's vision was to convert Trombay into an Industrial Versailles of Bombay He was always fascinated by the impressive palace gardens of Versailles in France where the beauty of Nature was tamed and controlled by the skillful hands of the French artists He therefore wished to treat a part of the Trombay Establishment on the pattern of Versailles gardens However, he wanted typical tropical plant materials used in this garden The concept of the Bougainvillea garden was thus born Tropical plants provide a lush green mantle but they lack the bright cheerful colours which the temperate flowering plants offer Bougainvillea plants provided the answer to these problems

Whenever a landscape plan was submitted to Dr. Bhabha for his consideration, he spent his valuable time on it to study what would be the ultimate shapes and sizes of the tree clumps and whether their groupings were effective enough to add to the aesthetics of the place He also knew well that landscaping was not merely limited to haphazard placing of flowering plants by unskilled hands It needed a horticultural scientist to choose the right plant in the right place and a visionary artist to specify the plant material to give colour, harmony, balance and rhythm to the whole composition

Connoisseur of trees

Dr Bhabha's observation of trees was just remarkable. Wherever he went, his keen eyes caught attention of every unusual tree Once when he was in Bangalore he saw a Casuarina tree with foliage which looked a little different from the other Casuarinas we normally see. Actually the difference was so subtle that even a trained horticulturist would not have noticed it. But Dr. Bhabha's eye did not miss it He telephoned me in Bombay to ascertain if it was not a different species of Casuarina When he was told that this could have been a possibility he immediately asked me if he could collect the cones which were lying on the ground and send them to me for trying out the new species in the Botanical Gardens of Trombay I explained to him that the cones which had fallen down would not have any seeds in them. The dehiscence of the fruit and the dispersal of the seeds of Casuarina take place while the cones are still on the tree He then had the seeds collected from the cones still hanging on the tree and despatched them by courier service so that no time was lost and the viability of the seeds was not affected We got the seeds sown and found, as the plant grew, that it was really another rare species of Casuarina These plants are still flourishing in the Botanical Gardens of Trombay

Love for trees

The study of the landscape proposals by Dr. Bhabha was far from casual. He used to apply his mind to them thoroughly. While planning roads in Trombay Establishment he observed from the landscape plan that an old mango tree came in the way of one of the roads The civil engineers had recommended complete removal of the tree to have a straight road Dr Bhabha was very unhappy with this proposal He felt that the tree which had lived there for over a hundred years had every right to continue to stay in the same spot As there was enough space around the tree to modify the road layout, he suggested realignment of the road to save the tree The tree had given a character to the whole area for over a century and is still happily standing there as a living sculpture Also, along the approach road to the Tata Institute of Fundamental Research there was a large Rain tree which came in the way of the road construction As this road alignment could not be changed, because the local conditions could not permit it, he had the tree transplanted in the adjoining locality

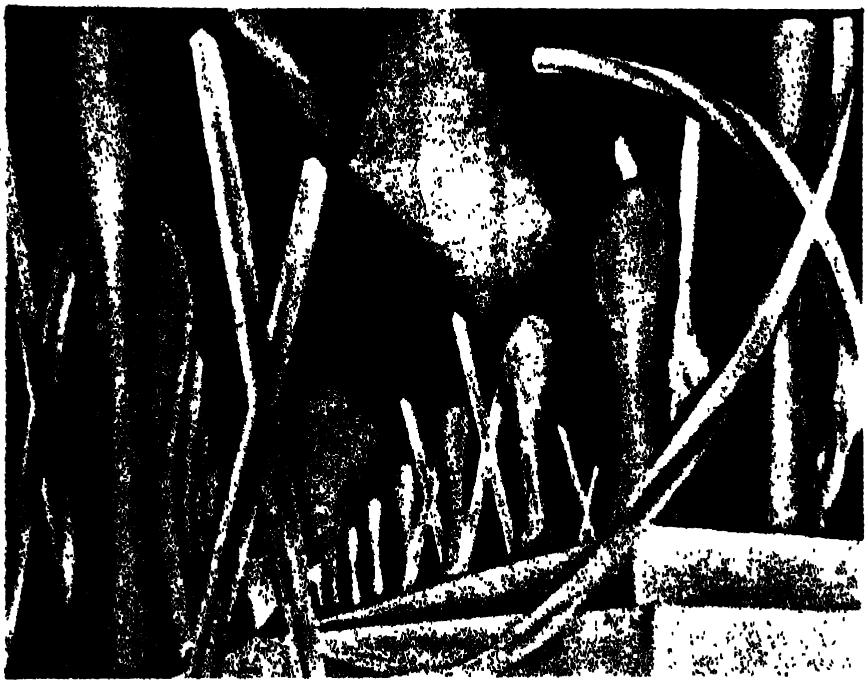
Once while coming from his house to Trombay Establishment he saw a few people cutting a Rain tree along Peddar Road He stopped to inquire why they were cutting the tree and whether they had the legal sanction to do so. He was told that the tree was disposed off by the Municipal Corporation as it fell in the road widening line and that they had purchased the tree for the highest bid He requested the workers to stop cutting it further till he found out whether the tree could be saved As soon as he reached Trombay he told me to examine whether it was possible to transplant and save the tree When I inspected the site I found that the tree was completely mutilated I reported to him that it would not be wise to spend a large sum of money on transplantation of the tree which had lost its aesthetic value He immediately asked me that if you were a doctor would you not try to save a patient who had third degree burns which had made his face disfigured. He also told me that scientists and artists should not waste their talents on bothering about the monetary involvements of the projects Their duty is to come out with their best in the larger interests of the mankind Financial wizards and administrators are paid for finding out ways and means to make the funds available for any good cause

I moved the Rain tree into the neighbouring compound and it is still doing well in its new home after two decades of its transplanting This was actually the beginning of the era of transplanting large trees in our country I shifted a very large number of trees thereafter and other organisations followed suit.

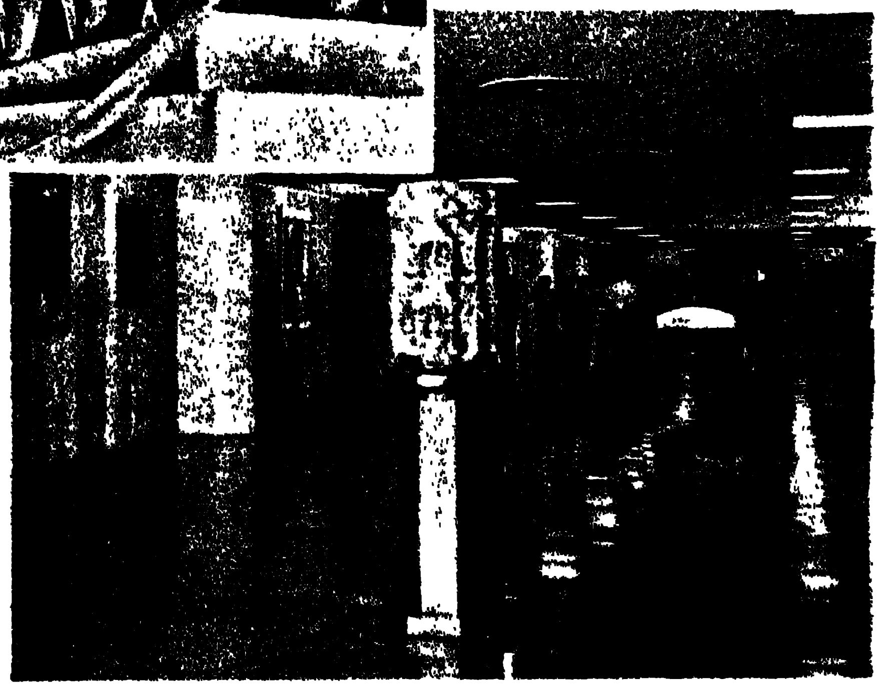
When the Tata Institute of Fundamental Research in Colaba grew in size, a number of Peepal, Banyan and Barringtonia trees had to be relocated in other places to make room for the new laboratories Each one of them was saved by transplanting and all of them are doing well in their new homes It is difficult to believe that the majority of the large trees in the gardens of the Tata Institute of Fundamental Research are the ones

number of cultivars of Bougainvillea and Canna.

Dr. Bhabha used to take so much personal interest in gardening that all his leisure hours were utilised in such activities. I remember the day he left to catch his fateful flight. It was a Sunday and we were working on the garden plan of the Industrial Versailles of Bombay at his residence. It was six o'clock in the evening and he was getting late to catch the flight. He collected all the papers and told me that he would further go through them on the flight and return them to me the next day with his comments



Bhabha's last painting



The T.I.F.R. foyer

which were given a new lease of life at the instance of Dr. Bhabha Also, he could not resist when he saw that some of the trees in the Malabar Hill area were being removed for the construction of the skyscrapers, for immediately he invited the attention of the Prime Minister, Mr Jawaharlal Nehru, and requested him to help in stopping the massacre It was because of this timely intervention that the Malabar Hill area is still retaining some of its own glory with trees, inspite of all the pressures from the builders to convert it into a concrete jungle

Science and gardening

Dr. Bhabha used to travel the world over for his scientific pursuits, but however busy he was, he never missed an opportunity to see the gardens around the places he visited He used to take photographs and make sketches of what he appreciated He used to write to me about anything which he thought was good enough for introduction in the gardens of the Atomic Energy Establishments Here is a copy of the letter he wrote from Geneva informing how the flower beds in the hotel, where he stayed, looked like

As a scientist Dr Bhabha always believed in creating new experiments Twenty five years ago it was believed that it was impossible to grow roses in Bombay But with his initiative, Trombay Establishment started growing roses and in 1960 there were as many as 750 named varieties growing successfully in the Rose Garden. Trombay could also boast of growing the largest

I am sure he must have been reading the same papers and thinking about the trees even when his plane crashed into the Alps The trees must have shed their leaves in grief on learning of his sad demise

Mr Vaidya was closely associated with Dr Bhabha and was chiefly responsible for translating into practice his landscape designs He was Head, Landscape Architecture section, Bhabha Atomic Research Centre, till recently At present he is a consultant

Continued from page 19

detectors above the earth atmosphere, such that cosmic ray particles could be classified and studied as they exist in interstellar space, that is before their energy was transformed by collision in the air into various forms of matter Such balloons were then a guarded monopoly of the U S but were soon duplicated at the institute with domestic raw materials Thus, India became the second country which could (before Sputnik) make extensive measurements more than 30 km above the Earth

In short, the choice of the largest of the initial research programmes satisfied the following conditions

1 It brought the institute into the forefront of science by exploiting favourable geographic conditions peculiar to India

2 It could be carried out with domestically developed equipment within a realistic financial envelop

3 It made Indian scientists familiar with techniques which later could be used in other advanced branches of science and industry

These very same considerations dominated the later additions to the programme. Thus, the study of high energy neutrinos was conducted in the Kolar gold mines as it required a deeply buried underground laboratory (before energetic neutrinos could be produced in large accelerators) Another example of such additions to the program was the construction of a powerful and large radio telescope which consists of a linear array of rather simple home produced antennas Its uniqueness and scientific power lay in its deployment strictly parallel to the earth's rotational axis, thereby exploiting deftly the hilly nature of India's most southern regions This is one of the few regions where the condition could be satisfied

The institute's early work consisted in producing a strong source of slow neutrons, which would permit India to participate from the start in exploiting the nuclear fission process discovered a few years before the foundation of the institute Subsequently, for enlarging the scope of the institute's programme during the first two decades, groups for building computers and magnetic resonance apparatus were set up Also, work was initiated in the fields of molecular biology, x ray and gamma ray astronomy All these subjects, have become extremely fruitful and are still close to the centre of contemporary scientific interest

Explaining the design of the Apsara reactor to a group of senior scientists and technical personnel

I would also like to mention examples where strong support from Bhabha permitted some groups to modify and adapt their programme to the rapid progress in science While cosmic rays were an ideal subject for advanced research in the early fifties, the new expensive particle accelerators began to produce such particles in the laboratory and take over the study of transformation of energy into matter at higher energies Therefore, the question arose as to the how to utilise the expertise acquired in cosmic ray studies, in other areas of research The solution was to begin the study of radioactive tracer isotopes produced by cosmic rays Like the radio isotope C^{14} first employed by Willard Libby (Nobel Laureate) many rare radioactive nuclei are produced in the atmosphere and precipitated They then mingle with geophysical, geochemical, hydrological and biological processes on the earth s surface The institute developed new techniques for isolating and employing many new tracers which have become important in various branches of the earth sciences It was in 1955, that, it was proposed to study the isotope Be^{10} which, because of its long half-life, (1 6 million years) has proved to be useful in the study of land erosion on continents and ocean floor phenomena such as the growth of manganese nodules, sedimentation rates etc

The success of Homi Bhabha as the director of the institute for fundamental and experimental research was mainly due to his ingenious choice of the initial fields of concentration This created the necessary self confidence in his research staff, followed by careful decisions of promoting certain proposals for enlarging the programmes The proposals permitted the institute to remain in the forefront of contemporary science

Scientists whose skills were developed in those programs at the TIFR have now been placed in prominent positions in government, industry and in research centres, occupied with space research, oceanography, geophysics etc These skills are also the base of the development of India's nuclear power, electronic, vacuum and other industries

For all this, credit should be attributed to Dr Homi Bhabha's genius as an administrator, scientist and research director of our times

Prof Peters is with the Danish Space Research Institute Lyngby, Denmark Earlier he had spent eight years at the Tata Institute of Fundamental Research at the invitation of Dr Bhabha

A 'COSMIC' MAN

HIGH energy and elementary particle physics is one of the areas of science today responsible for tremendous advances in the frontiers of knowledge leading to an understanding of the ultimate constituents of matter and radiation The field is the combined offshoot of two branches of physics, namely, nuclear physics and cosmic ray physics, and may be said to have had its beginning in the early 30s of this century. The late Dr. Homi Bhabha made very significant theoretical contributions in the crucial development phase of this field which coincided with the early phase of his own research career in physics at the University of Cambridge, England, which began immediately after he completed the tripos in engineering sciences there. Happily and fortunately for India, Dr. Bhabha returned to his native land in 1939 and initiated work in the field of cosmic ray studies at the Indian Institute of Science, Bangalore, and later founded the Tata Institute of Fundamental Research in 1945. Dr Bhabha's personal interest and involvement in this area of research has resulted in the development of one of the most powerful theoretical and experimental groups which over the last four decades have made pioneering contributions to many aspects of cosmic radiation, high energy physics, and particle physics. The first ever international conference on 'Elementary Particles' held in Bombay as early as 1950 under the stewardship of Dr. Bhabha himself followed by two International Conferences on Cosmic Rays--one in 1963 at Jaipur and the other in 1983 at Bangalore—are clear recognition of the level of Indian effort in this field and how rapidly it has grown Pursuit of this area of research has had many other important fallouts as well By enabling scientists to do front-ranking research comparable to their counterparts anywhere in the world it helped to retain many of them within this country It also attracted many brilliant young scientists back to this country to pursue research in this field. It is also an area in which there has been very successful international collaborations Development of a variety of particle detectors, fast electronics and instrumentation, and sophisticated glass technology have been some of the other important fallouts of this programme.

In order to appreciate the full significance of the scientific contributions of Dr. Bhabha, it is necessary to familiarise ourselves with the status of research in physical sciences in the early 30s.

Investigations on the conduction of electricity in gaseous discharge had led J.J. Thompson towards the end of the last century to the realisation that the phenomenon could be best understood if a particle of negative charge possessing the same charge to mass ratio, irrespective of the substance in which the discharge is induced, is postulated. This particle which later came to be known as "the electron" had to have a mass at least a thousand times smaller than that of the positive ion recognised in the discharge. In the succeeding years X-rays and radioactivity were discovered and in the year 1911, Rutherford, on the basis of experiments on the scattering of alpha particles showed that at the core of the atom was the nucleus confined to a much smaller volume which essentially carried all the mass of the atom. It soon became clear that the nucleus of the hydrogen atom, "the proton", was the fundamental constituent of all matter and carried a positive charge in magnitude exactly equal to that of the negative charge on the electron. The anomalies observed in the properties of the spectral radiation from hot bodies led to the famous Planck hypothesis of the quantum of radiation, the photon. This idea was successfully used by Einstein to explain the photoelectric effect. Bohr's atomic theory and quantum mechanics explained all aspects of the emission of radiation by different substances at varying temperatures. Dirac's quantum theory of the electron explained many of its properties including the existence of spin and led to the interesting idea of antiparticles and the possible existence of magnetic monopoles. In the year 1912 another major discovery was made. Victor Hess going upto an altitude of 16,000 feet in a Gondola lifted by a balloon and carrying an ion chamber with him convincingly demonstrated the existence of a penetrating radiation of extra-terrestrial origin. This radiation was given the name "Cosmic Radiation" by Millikan Efforts to understand the complex features of the radiation led to the recognition by 1930 of the existence of a soft component and a penetrating component. The soft component was easily absorbed in a few centimetres of lead while the penetrating component penetrated tens of centimetres of lead. Occasionally in cloud chamber pictures the presence of several simultaneous particles had been recorded Geiger counters separated by tens of centimetres in a horizontal plane also recorded frequently simultaneous discharges which could be understood only in terms of the incidence of several simultaneous charged particles Peculiarities had been noticed in the absorption characteristics of the penetrating component of the radiation. It had been found that for equal amount of matter, more of the penetrating component was lost in an extended medium like air than in a condensed medium like lead, or water

Major discoveries

In 1932 two major discoveries were made. Chadwick discovered the neutron, the neutral counterpart of the proton. This resulted in a clarification of the constitution of the nucleus which till then was considered to be composed of protons and electrons. It became absolutely clear that the nucleus consisted of protons and neutrons. The other major discovery in 1932 was the discovery of the positron by Anderson in cosmic radiation. The discovery of the positron as the anti-particle of the electron was a great triumph to the relativistic quantum mechanical theory of the electron

by Dirac. An immediate consequence of this discovery was the recognition of the possibility of pair creation by high energy photons as they pass near nuclei. Experimentally the phenomenon of pair creation was soon established One of the important questions that arose with discovery of the neutron and the subsequent investigations in the field of nuclear physics was the nature of the nuclear force—what held the neutrons and protons together inside the nucleus? In this connection a Japanese graduate student Hideki Yukawa had postulated the so-called "meson theory of nuclear forces" according to which the proton and neutron were bound together by the exchange of particles called mesons. The theory was based on the analogy of exchange of photons between charged particles in electromagnetic interactions. Because of the short range of nuclear forces Yukawa had postulated that the mesons should have finite mass, unlike the photon which had zero mass The particles had to be charged since they caused interaction between the proton and the neutron, one a charged particle and the other neutral

It was into this scientific milieu of sub-atomic particles and forces of interactions between them that Dr Bhabha stepped in as a young research worker at the age of 20, a fresh graduate from the University of Cambridge

One of the important theoretical problems that was being investigated was on the behaviour of charged particles as they passed through matter and lost their energy and the associated physical processes. Bethe and Heitler deduced the cross-section for bremstrahlung radiation by charged particles and for pair production by high energy photons on the basis of relativistic quantum mechanics and worked out the energy loss of high energy charged particles as they passed through matter. They came to the rather surprising conclusion that the mean range of a 10 GeV electron is only about 1.8 kms of standard air. This appeared inconsistent with the

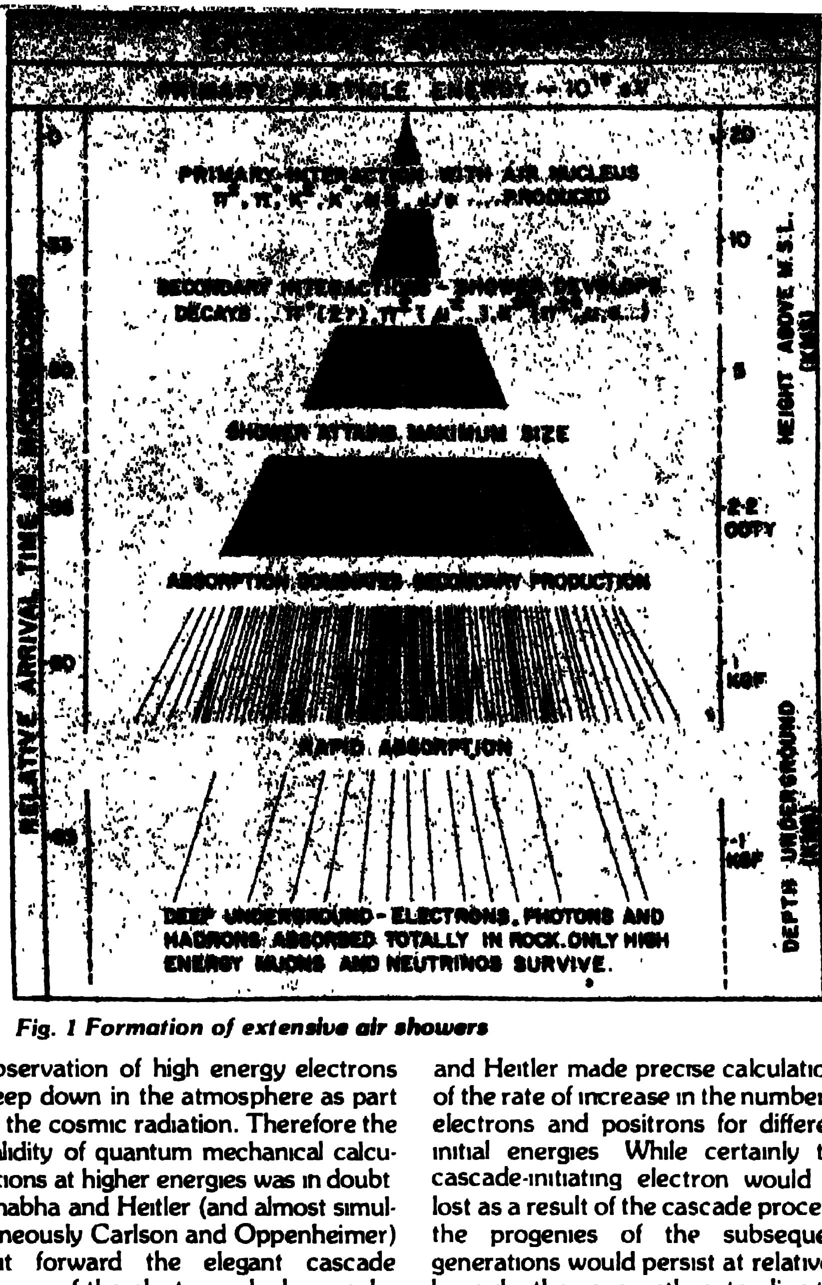


Fig. 1 Formation of extensive air showers

observation of high energy electrons deep down in the atmosphere as part of the cosmic radiation. Therefore the validity of quantum mechanical calculations at higher energies was in doubt Bhabha and Heitler (and almost simultaneously Carlson and Oppenheimer) put forward the elegant cascade theory of the electron which considerably clarified the problem While Bethe and Heitler were quite correct in deducing the mean range, what they had missed was that a high energy electron passing close to a nucleus would give rise to a high energy photon which in turn would undergo pair production giving rise to an electron-positron pair both of which would give rise to further high energy photons and this process would continue until the energy of the electrons, positrons and the photons, which degraded continuously, became quite small The net result would be the development of an electromagnetic cascade—the number of electrons and photons would initially multiply and then gradually decrease Bhabha and Heitler made precise calculations of the rate of increase in the number of electrons and positrons for different initial energies While certainly the cascade-initiating electron would be lost as a result of the cascade process, the progenies of the subsequent generations would persist at relatively large depths apparently extending the range of the electron The cascade theory provided straightaway an explanation for the cosmic ray showers and the anomalies observed in the absorption characteristics of the soft component

Bhabha in a classic paper entitled "On the Penetrating Component of Cosmic Radiation" communicated to the Proceedings of the Royal Society in July 1937, critically analysed the then existing experimental data on the soft and penetrating components and concluded that a 'breakdown' of the quantum mechanical theory of radiation as was envisaged by some, would not explain the latitude effect of cosmic rays, the large number of 10 GeV electrons observed at sea level

Fig 2 Extensive air showers as detected by Ooty cloud chambers

and the shape of the transition curve of large bursts He pointed out that on the contrary all these features find a natural explanation if the radiation has also new particles with mass between those of electrons and protons, something of the order of 100 electron masses Some of the cloud chamber experiments which were designed to identify the nature of the penetrating particles through a measurement of ionisation and energy lost, were also leading to similar conclusions Finally the experiment of Anderson and Neddermeyer with a 1 cm thick platinum plate across the middle of the magnetic chamber clinched the issue The mu-meson as the penetrating particle was discovered Street and Stevenson soon established that the mass of the mu-meson was about 200 electron masses In the flush of the discovery of the mu-meson, it was natural to identify it straightaway with the Yukawa particle that had been postulated to explain the theory of nuclear forces. Very soon it became apparent that there were serious problems with this identification. The lifetime of the mu-meson as deduced from the absorption rate in the atmosphere was a hundred times too long—in the region of microseconds, even after taking into account the relativistic time elongation effect which Bhabha had predicted for these particles The lack of nuclear absorption effects of negative mu-mesons when stopped in a light substance like carbon did not conform to the expectations of the interacting nature of the Yukawa particle

This was roughly the status of cosmic ray and elementary particle physics when Dr Bhabha returned to India and over the next few years established the Cosmic Ray Research Unit at the Indian Institute of Science, Bangalore, as part of the Department of Physics which was headed by Sir C. V Raman The tremendous scope for both theoretical and experimental research that this field had opened up was clear to him He was also aware of the special advantages that India had for cosmic ray work because of the wide range of latitudes available from the magnetic equator in the south to 25° N magnetic latitude in Kashmir within the boundaries of the country and a wide range of high mountain stations While continuing his theoretical studies along with a band of young physicists and mathematicians he had collected around him, on elementary particles, cascade theory, meson production etc., he embarked simultaneously on a programme of experimental studies of the penetrating component While he interacted with the mathematicians of the Central College in his theoretical studies, he interacted with the communication engineering department of the Institute in his experimental pursuits He designed, based on his first hand familiarity with cascade theory, a unique Geiger counter telescope that preferentially selected the penetrating component without requiring too much lead absorber and flew the telescope in an aeroplane to an altitude of 32,000 ft. This constituted one of the first measurements of the

latitude effect of mu-mesons at high altitude. He got a 12" diameter cloud chamber constructed (identical to the one that was operating in Prof. P.M S Blackett's laboratory at Manchester in England) and initiated a systematic study of the scattering properties of cosmic ray mesons

When TIFR was started in 1945, the cloud chamber was brought to Bombay from Bangalore and investigations in scattering of muons continued Plans to build larger cloud chambers were undertaken The High Altitude Studies group started making balloon flights at a number of stations in India to measure the intensity of the penetrating component at different latitudes A Glass Shop was set up to manufacture the large number of Geiger counters needed in the Institute itself

During the same period Prof Powell of Bristol University in collaboration with Ilford Ltd had succeeded in developing highly sensitive nuclear emulsions for recording fast charged particles In the hands of Powell and his collaborators the nuclear emulsion developed into a powerful technique, for cosmic ray research and led to the discovery of the pi-meson in 1947 The discovery of the pi-meson removed many of the anomalies that had persisted about the cosmic ray meson It became clear that the Yukawa meson was the pi-meson which spontaneously decayed into a mu-meson and a neutrino with the lifetime of 2×10^{-8}s as expected. It was also highly interacting and caused nuclear disintegrations when it passed through matter. The discovery of the neutral counterpart of the pion, the pi-zero meson solved the problem of the origin of cascade showers in the atmosphere The neutral pion spontaneously decayed into a pair of high energy gamma rays in a time less than 10^{-14}s and the high energy gamma rays initiated electromagnetic cascades in the atmosphere giving rise to the soft component of cosmic radiation

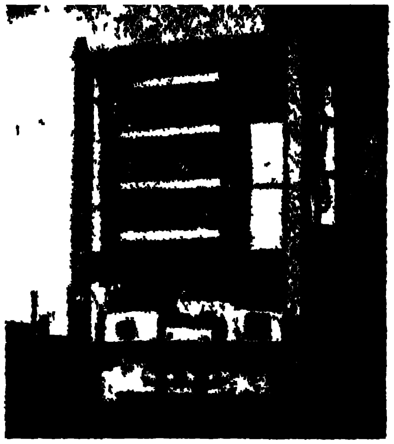
Over the years the group formed by Dr. Bhabha to study cosmic ray interactions with the help of nuclear emulsion techniques became one of the most important groups in the world

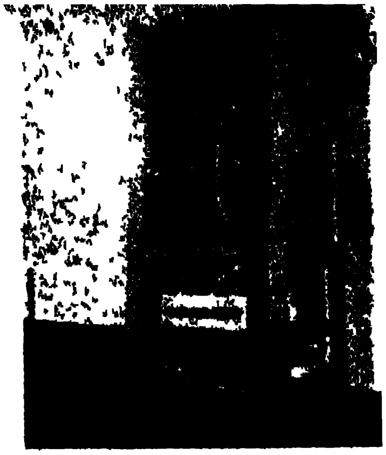
Dr Bhabha who had kept track of these developments and was a personal friend of Powell, started a nuclear emulsion group in the Institute in 1947 itself Over the years this group became one of the most important groups in the world for the study of cosmic ray interactions and for studies on the nature of the cosmic radiation incident at the top of the atmosphere

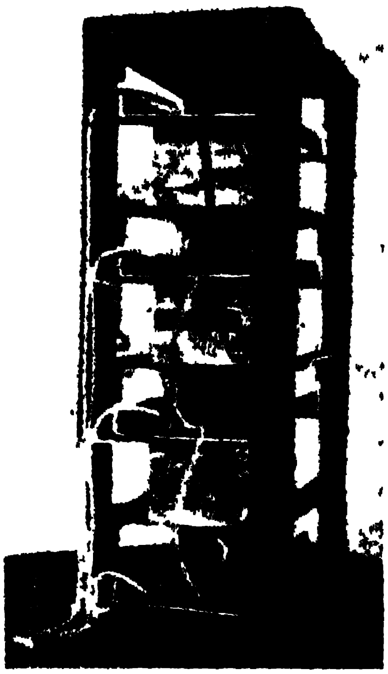
One of the important puzzles that remained was to understand the source of the charged and neutral pions Theorists like Bhabha had speculated that these may be produced in the collisions of the primary particles Soon with nuclear emulsions flown to balloon altitudes, and cloud chambers set up at mountain altitudes, it became possible to register the act of meson production in high energy nuclear encounters The cosmic ray jigsaw puzzle was completely solved It became clear that there was a primary radiation predominantly of protons incident at the top of the atmosphere In the nuclear collisions of the protons, the charged and neutral pions were produced While some of the charged mesons interacted as they travelled downwards in the atmosphere, a large fraction spontaneously decayed into muons and gave rise to the penetrating component The neutral pions decayed into gamma rays and gave rise to the soft component through the development of cascade showers

Experiments with nuclear emulsions flown to high altitudes revealed that the primary component consisted not only of protons but also of heavy nuclei It so happened that Prof Bernard Peters of the University of Rochester, USA, who was involved in this major discovery, came as a delegate to the Elementary Particle Conference organised by Dr Bhabha in December 1950 At the invitation of Dr Bhabha, he joined TIFR as a Professor in 1951 and stayed on at the Institute for 8 years This gave a big boost to the cosmic ray programme of the Institute in general and to the nuclear emulsion programme in particular In 1955 Prof M G K Menon who had spent 8 years at the University of Bristol under Prof Powell and had made pioneering contributions in the field of elementary particles also joined TIFR The balloon flight programme gained momentum, the development of large volume plastic balloons were undertaken for a variety of experiments in cosmic rays Over the years this activity has grown to such an extent that a permanent Balloon Facility for fabrication of plastic balloons and launching them has been set up at Hyderabad So far 112 flights have been made for cosmic ray experiments, and 96 for X ray, gamma ray astronomy experiments

I should also mention another line of activity in the field of cosmic rays initiated by Dr. Bhabha, which over the years has also developed into a major activity of the Institute and has brought profuse international accolades A few weeks prior to the Elementary Particle Conference in December 1950, late one night Dr Bhabha called me to his office and said





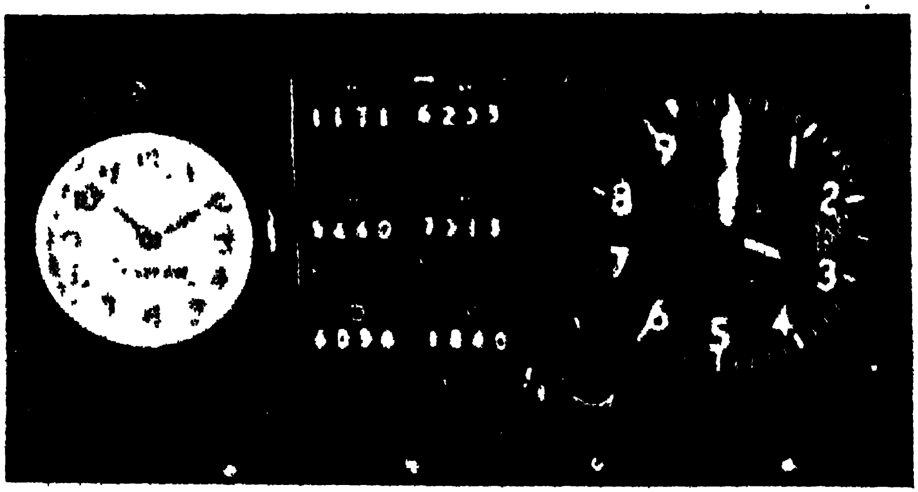


Top: Views of one of the units sent up to 32,000 feet with its sides removed. The top of the unit contains two cosmic ray telescopes. The electrical amplifiers are on the lower shelf. The dry batteries are at the bottom.

Left: A cosmic ray telescope with four counters. The three thick lead blocks traversed by the cosmic rays are seen between the counters.

Bottom right: The new anti-coincidence method for excluding the soft component.

Bottom left: A photographic record taken during the high altitute experiment. The six cosmic ray readings are shown in the middle. The altitude indicated by the altimeter on the right is 30,000 feet.




that I should plan to carry out some cosmic ray experiments in the Kolar Gold Mines—first I should make a systematic measurement of the intensity of the penetrating particles at various depths underground and then chalk out a programme of experiments to determine whether the particles encountered underground were all mu-mesons or whether other types of particles were also present. Well, the first series of experiments were started in October 1951 and ended in 1953 The experiments could be conducted only upto a depth of 1000 ft below ground because of the decreasing flux of cosmic rays and the relatively small size of the counter telescopes A newly constructed 18" diameter multiplate cloud chamber had just started operating in the mines when because of the decision of the government to close down the mines we had to leave abruptly and continue the experiments in an abandoned railway tunnel at Khandala However, the mines did not close down We went back there in 1959 and the second phase which started then has continued almost uninterrupted in a variety of directions at a variety of underground levels right down to 9000 ft below ground The second phase had added advantages. Developments in detector technology in the intervening years enabled us to build larger-area more sensitive detector systems Prof Menon got interested personally in the deep underground experiments Prof Mayake who had come to TIFR as a visiting professor in 1960 also got interested in these experiments which heralded the beginning of a fruitful Indo-Japanese collaboration which even after 24 years, is still continuing For almost a decade a team of U K scientists from the University of Durham, Prof Wolfendale and his collaborators, also got involved in the experiments at KGF The experimental results on very high energy muons and neutrinos from KGF were anxiously awaited by the cosmic ray community, particularly at the Biennial International Cosmic Ray conference The TIFR group also set up a unique installation there—an extensive air shower array comprising 64 scintillators at the surface with large area detectors deep underground at different levels to record the associated muons This unique air shower laboratory was inaugurated by Dr. Bhabha in December 1964

The experience and expertise gained over almost three decades in the KGF mines helped considerably in setting up at a remarkably fast pace the first "proton decay detector" in the mines at a depth of 8000 ft. below ground As is well known now, the eyes of the world are on this experiment for a crucial and important confirmation of what is known as the Grand Unification Theory -unification of the different forces of nature

As far back as December 1955, the cloud chamber group of the Institute moved to the mountain station at Ootacamund and set up two multiplate cloud chambers, one above the other (Rani and Maharani as they were called) to study nuclear interactions by cosmic rays, in particular the production of strange particles—heavy mesons and hyperons, which had just then been discovered The laboratory was set up in a couple of hutments that were part of the Raj Bhavan estate and which Dr Bhabha had obtained for us through the courtesy of the then Governor of Tamil Nadu, Sri Sriprakasa Soon an extensive air shower array was set up at this laboratory In January 1965, the world's largest multiplate cloud chamber was installed there as part of the air shower array Dr Bhabha who spent a few weeks on vacation at Ooty in January of that year, was thrilled to see the world's largest cloud chamber operating there Experiments on cosmic rays are still continuing at this laboratory

In this article I have confined myself to highlight only just one aspect of the multi dimensional many-splendoured personality of Dr Bhabha In TIFR alone, apart from fostering cosmic ray research he was responsible for seeding, nurturing and growing many other disciplines The School of Mathematics of the Institute which he started almost at the inception of the Institute, is acknowledged to be one of the finest Schools of Mathematics in the world today. Theoretical Physics, Nuclear Physics, Solid State Physics, Chemical Physics are other areas initiated by him in which work is carried out at the international level of excellence. Radio Astronomy and Molecular Biology stand out as glowing examples of the success of the philosophy that he followed in growing research in his institutions—of identifying the scientists first and building the activities around them I have also not touched upon the other aspects relating to the role he played in growing the Atomic Energy Programme of the country, the role for which he is rightly regarded as the Father of the atomic energy programme of India, nor have I referred to his role in the famous "Bhabha Committee Report on Electronics" which formed the basis for the constitution of the Electronics Commission and the Department of Electronics, nor the initial boost he gave to the Space Programme which formed part of the atomic energy programme in the early stages

Bhabha was not only a scientist par excellence, but also a connoisseur and patron of art and music The idyllic locations of the various institutions he founded, the elegance and beauty of the buildings and gardens, the collection of sculptures and paintings are living testimony to these aspects of his life It is absolutely no exaggeration to say "another like him will not pass this way even in a millennium"

Prof Sreekantan is Director of the Tata Institute of Fundamental Research, Bombay He has been closely associated with the cosmic ray research work at Kolar Gold Fields

"Fantastically talented but so fastidious about standards that he was never a dilettante. Whatever he set himself to do, he did as a professional—but one who worked for love. So he became a living proof that scientific excellence can go with excellence in art."
Lord Redcliffe-Maud

Are you afraid of phobias?

S. Kapali

DID you know that the founder of Probability Theory, Pascal, feared open spaces and Sigmund Freud had a fear of travel? Phobias, those extreme, irrational fears towards certain objects and situations, are many, though psychiatrists classify phobias as a single type of neurosis. Here is a list of phobias common and uncommon Check the word or phrase you believe to be closest to the meaning of the key word Answers on page 75

(1) **Acrophobia:**
(a) Fear of sky
(b) Fear of heights
(c) Fear of insects

(2) **Belonophobia:**
(a) Fear of sharp objects
(b) Fear of snakes
(c) Fear of man

(3) **Agoraphobia:**
(a) Fear of plants
(b) Fear of open spaces
(c) Fear of books

(4) **Xenophobia:**
(a) Fear of idols
(b) Fear of books
(c) Fear of strangers

(5) **Herpetophobia:**
(a) Fear of reptiles
(b) Fear of birds
(c) Fear of animals

(6) **Autophobia or monophobia**·
(a) Fear of being alone
(b) Fear of ideas
(c) Fear of birds

(7) **Musophobia:**
(a) Fear of enclosed spaces
(b) Fear of mice
(c) Fear of water

(8) **Arachnophobia**·
(a) Fear of lice
(b) Fear of being buried alive
(c) Fear of spiders

(9) **Nosophobia**·
(a) Fear of illness or disease
(b) Fear of sex
(c) Fear of strangers

(10) **Ochlophobia:**
(a) Fear of syphilis
(b) Fear of crowds
(c) Fear of poison

Of psyche and soma

THE patient is a forty year old executive, married with two children He has cancelled two previous appointments with me on account of heavy work He walks in with rather unpleasant expression, mops his face repeatedly and sits in an awkward manner

I am sorry for being little late doctor, but due to heavy work I could not

That's all right Now, what is your problem The physician who has referred you to me mentions that you are unwilling to consult a psychiatrist

Doctor, actually there is nothing wrong with me psychologically I have a strong mind and equally strong will power I am not a weak person to have psychological problems Doctor, is there any reason to believe that chest pain could be psychological?

It could be But let's not talk about possibilities

I have chest pain, right here (points to left side of chest) actually very severe pain and it lasts for at least one to two hours Then my heart beats very fast, I almost hear it beating in my ears I also have gas trouble (points to upper part of the abdomen) and then I feel very uneasy, sort of restless

Is the chest pain so severe that you feel you are going to die?

Yes

And when you think you are going to die your heart beats faster!

Yes, I am afraid I will have a heart attack But the heart specialist says my heart is normal He has checked me several times and taken many cardiograms Once he asked me to do some exercises and then took my cardiogram, even that was normal He told me I have no heart trouble But doctor, I still get these attacks of pain

When did these attacks of chest pain occur for the first time?

That was about six months ago I joined the office after a leave of few days Actually I lost my father, and hence had to take some leave When I resumed work, I had to attend to heavy work in the office I had an important board meeting, every thing depended on how I performed in that meeting No, I was not feeling much tension But one day when I was in my cabin I realised that my hands and feet are getting cold, my heart is beating fast and mouth is becoming dry I stopped for sometime and continued working It was terrible The same day I had that meeting, I managed it somehow and got the promotion But since then this trouble has

Many physical and mental conditions often thought to be purely psychological have, in fact, a physiological origin. These can often be alleviated by proper medication and counselling

started Actually I should be happy that I fulfilled my father's last wish and I got this post

What did your father die of?

Heart attack

I see Tell me about your sleep and appetite

I can't fall off to sleep easily I am usually awake till late midnight I have not much appetite also In fact, I have lost a couple of kilos since last six months

Does your sleep refresh you?

No doctor When I get up in the morning I feel very tired

Do you wake up very early in the morning and then you can't sleep?

Yes

How do you feel mentally? How is your mood these days?

Very low I feel kind of blue, not at all energetic as I used to feel earlier And doctor since we are at it I have lost interest in sex Earlier it was not so These days I just don't feel like indulging in such activity Of course, my wife is very understanding She doesn't complain but I am afraid if it continues like this I may lose my power of sex and that's a terrible idea

Is life becoming unbearable to you that you feel like ending it?

Yes doctor, you are right I know it is wrong to think that way but sometimes I do feel like that But please don't tell my wife about it, she will be very upset I am so attached to my family that I will not commit suicide

Ok But is the thought of ending life all pervasive, meaning it is always there in your mind Is it a constant preoccupation?

No, only when I have some problems in the office and even these are created by me

I don't get you

You know doctor how it is in large companies, there is always the spirit of competition I get irritated even by small problems and lose my temper on my subordinates

You weren't like this before?

No, I always liked competitive spirit I used to say it keeps everyone on toes But now I am afraid that I shall fail and not come up to the expectations of my bosses, colleagues This thought is haunting me for the last six months this competition is killing me

No, it is not killing you It is stressful to you

Doctor, tell me is there anything wrong with me?

Yes, you are suffering from "depression" And when I say depression I am using a medical term Precisely, you are suffering

from a mood disorder or an affective disorder

You mean whatever I am feeling has only psychological basis It's not real?

No, I didn't say that Whatever you are feeling, experiencing is real Nobody can deny that It is psychological in nature

Let me explain you have mainly two symptom clusters The primary cluster is depression and the second is anxiety Our body has been divided into various systems, e g the cardio-vascular, respiratory, etc Similarly, the human mind has been divided into various faculties there is the thought process, the memory system and the feeling component or the mood, etc Your problem lies in the mood system The depressed mood, suicidal intentions, sleep disturbances are all symptoms of mood disorder While chest pain, palpitation, heart burn, quickening of breath are symptoms of anxiety

These symptoms though experienced mentally have organic basis or their origin lies in the disturbed neurochemical functions of the brain

You mean something is wrong with my brain

No The neurochemical change is at cellular level In your brain there are billions of nerve cells called as neurons These neurons are in contact with each other at junction referred to as a synapse The transmission of messages from one neuron to the adjacent neuron occurs through the synapse, with the help of chemical substances or neurotransmitters They are chemically known as norepinephrine, serotonin or 5 hydroxy tryptamine If there is a shortage of these neurotransmitters at these synapses in some parts of the brain the transmission of messages gets disturbed This causes depression

Then if I consume more of these chemical substances, shall I be able to correct the imbalance in the brain? Can this be cured by proper diet?

Unfortunately, diet cannot cure this Secondly, if you consume these substances they will be destroyed in the alimentary system If I inject them, they won't reach the neurons But certain drugs which I shall be prescribing have the capacity to increase the levels of these neurotransmitters

How would drugs achieve this effect?

There are drugs known as tricyclic compounds (imipramine, amitryptaline) which prevent the destruction of the neurotransmitters This leads to accumulation of the existing neurotransmitters at the synapses facilitating the transmission of neuronal impulses It takes at least 10 to 15 days for this to occur

Till then I shall have no respite?

The antianxiety drugs I am prescribing will relieve symptoms of anxiety like chest pain, palpitations uneasiness, etc

You don't mean Calmpose I have been swallowing Calmpose off and on for the last couple of years

There are many drugs in the armentorium I know many people consume these drugs off and on without prescriptions But it serves no purpose as the drugs are not taken in proper dosage

Excuse me doctor for saying so, but I always heard that psychiatrists always give talking cure with the patients on a couch, you have been concentrating on drugs

Thank you for bringing this topic I shall of course be calling you to discuss the various problems you are facing This will enable you to deal with them confidently I am sure with these talking sessions or psychotherapy, you will be a more mature person There is no need for deep psychoanalysis The purpose of giving drugs is simple enough They will bring you in a frame of mind where you will be able to discuss your problems And of course, the relief from symptoms will be immediate

But what shall I talk about? I have told you everything

You haven't and I don't expect you to There are many things you mentioned briefly which need deeper understanding Like you talked about fulfilling your father's last wish

Let us not talk about these things We shall start with these anti depressant and anti anxiety drugs We shall meet every week for half an hour for psychotherapy sessions

The patient will require about 10 to 12 sessions of psychotherapy wherein an attempt will be made to help the patient develop insight into his psychological problems, eg the patient initially denied that he has a problem This use of denial as means of avoiding problem will be discussed The drugs will be continued for at least six months and then slowly reduced

Rajendra Barve

Dr Barve is a lecturer at the department of psychiatry, B Y L Nair Hospital Bombay

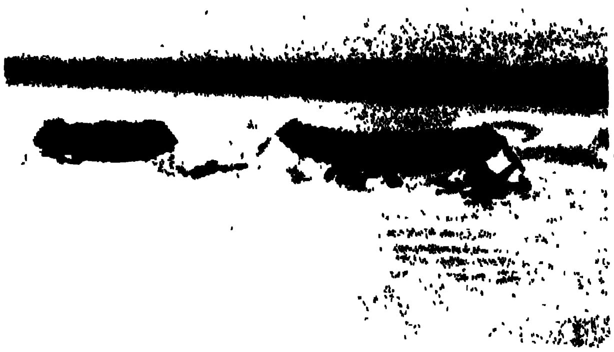
Malaria strikes

MALARIA and other mosquito-borne diseases are back again with a vengeance In 1983, the worst year so far in the last decade, 25 to 40 per cent of some of the urban as well as rural populations in India fell prey to malaria, complicated with viral as well as other 'no-cure' fevers 1984 may be still worse and the toll may run to millions

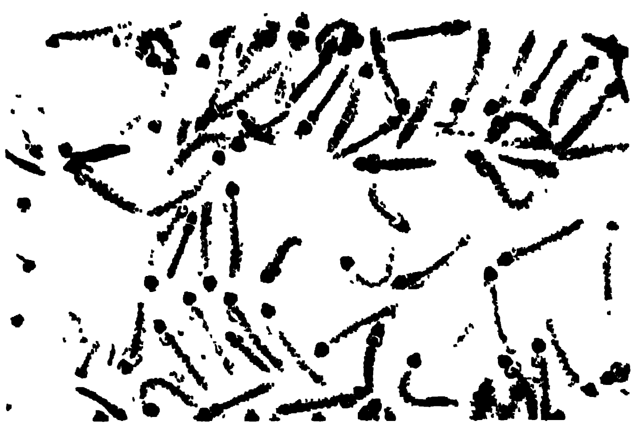
Pandemics of malaria have killed more humans than all the wars in history In India, it had always been the single major cause of devastating sickness and tremendous loss of life, and hence one of the serious hindrances to economic development However, the establishment of the malaria parasite-mosquito-man relationship, paved the way for malaria treatment and mosquito control measures Operational needs for intensive mosquito-control, along with the development and use of DDT as an insecticide from the middle of the Second World War, were the brightest landmarks for the 'conquest' of malaria Spectacular success of malaria control campaigns by two rounds of DDT spray followed, and in those heady days hopes were raised that malaria could be contained and then wiped out

The National Malaria Control Programme (1953 58) in co-operation with international agencies was efficiently implemented, and this led to its conversion to the National Malaria Eradication Programme (NMEP) in 1958 with still greater expectations The experts had, however, warned at that decisive stage that final success entailed continuity of dedicated efforts and constant vigilance combined with a sense of utmost urgency, and that any lapses, haphazard and incomplete measures and delay will inevitably lead to complete failure of the campaign because the incredibly adaptable mosquitoes have the ability to take advantage of the delay and human failures to develop resistance to insecticides

The prophetic warning came true The expectation was never realised By the end of 1964, just about the time near eradication of malaria was evinced, we started slipping back Severe focal outbreaks of malaria followed in most parts of the country The failure was officially confirmed by 1974 Billions of rupees and man-hours went down the drain The failure has been belatedly and variously imputed to serious administrative, operational and technical lapses and omissions poor management, unsound logistics, inefficiency and indifference, com



Rafts of tiny cigar-shaped eggs of Culex *mosquito*



Anopheles *larvae or wrigglers float horizontally*

Culex, Aedes, *and* Mansonoides *mosquito larvae suspended head downwards*

Pupae of different species of mosquitoes

back

placent attitude of all concerned, political interference, exhaustion of funds... In 1975 WHO commented on the lack of improvement in operational and epidemiological situation. In 1976 the situation became alarming with 6 5 million proven malaria cases in the country, and the threat has gone on increasing ever since

The 'switch back' to the so-called modified control and eradication programmes have not been of any help because of the lack of concerted effort, unsatisfactory supervision and execution in this regard in particular and for lack of sanitation and sewage disposal in general The results are reflected in the alarming resurgence of the diseases spread by mosquitoes as well as flies The hazard has further been intensified due to factors like disregard of traditional safeguards for prevention of mosquito breeding places incidental to engineering works (by PWD, Irrigation, Railways and local bodies), mass migration of labour, alarming rise in the price of insecticides and oils and their diversion from mosquito control to agricultural and changed irrigation patterns

Newer dimensions of the threat

We are back to square one, or worse There is cause for despair *Not only the mosquitoes have developed resistance to the once so successful insecticides, even the malaria 'germs' (blood parasites) have gained immunity to drugs, including chloroquine which had been most effective for preventing as well as treating malaria* Malignant tertian fever recurring every other day, caused by the blood parasite *Plasmodium falciparum*, the most dangerous of all the malaria parasites, is on the increase

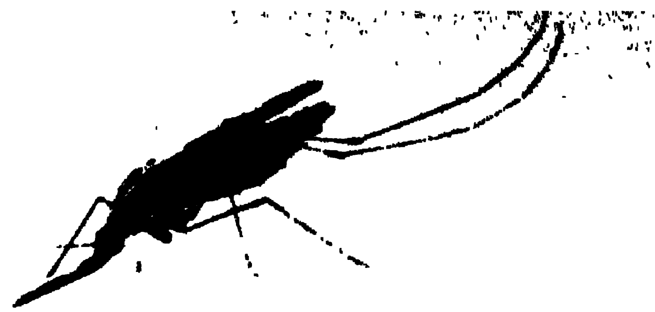
While, with the onset of summer, millions are exposed to the threat of increasingly devastating outbreaks of chronic or complicated malaria and other mosquitoborne fevers, most physicians are baffled by the mimicry of many other diseases manifested by malaria Their diagnoses, inconclusive in most cases, had no strategy to attack the near-epidemics of new or modified strains of mosquitoes or/plus a variant of the dreaded dengue, with higher mortality rates during 1983 Most physicians, however, agreed that large number of cases required hospitalisation due to lack of response to traditional or specific treatment Costly treatment remained beyond the reach of most sufferers, while the manufacturers of fake or substandard paracetamol and anti malarial drugs, quacks and unscrupulous physicians had the best of it The poor and underprivileged with insufficient nutrition are more vulnerable to disease Living in unhealthy and insanitary surroundings without proper drainage facilities, deprived of effective free or inexpensive treatment, unable to fight debilitating conditions, they are also the human reservoirs of most infections, including mosquito borne diseases

Research is in progress to develop vaccines, injectibles, economical and long-acting prophylactics and effective insecticides. But, barring miracles, these much awaited weapons may not be available soon enough And, another nation-wide programme to contain the menace which may even give a serious setback to our agricultural, industrial and social conditions remains well beyond the nation's pocket-book

The panacea

We need not suffer and live with these diseases We should take an active part in maintaining our own health and also be agents of change for health for our family and community The practice of a realistic and effective approach based on personal protection and self help is the real panacea beneficial to individuals and communities

There are nearly 290 species of mosquitoes in India, but just a few species spread a grim array of diseases to humans *Anopheles* mosquitoes transmit the plasmodium (blood parasite) that causes malaria fever Yellow fever virus is transmitted by *Aedes* mosquitoes The virus of dengue the break-bone fever that causes acute pain, very slow recovery and occasional death, is spread by the *Aedes aegypti* mosquito The tiny parasitic worms that cause filaria, elephantiasis, are carried by *Culex Aedes* and *Mansonoides* mosquitoes Some other



The resting pose of Anopheles *mosquito*

The resting pose of Culex, Aedes *and* Mansonoides *mosquitoes*

viral encephalities (brain inflammation) and haemorrhagic fevers are also spread by culex and aedes mosquitoes

Curbing the menace

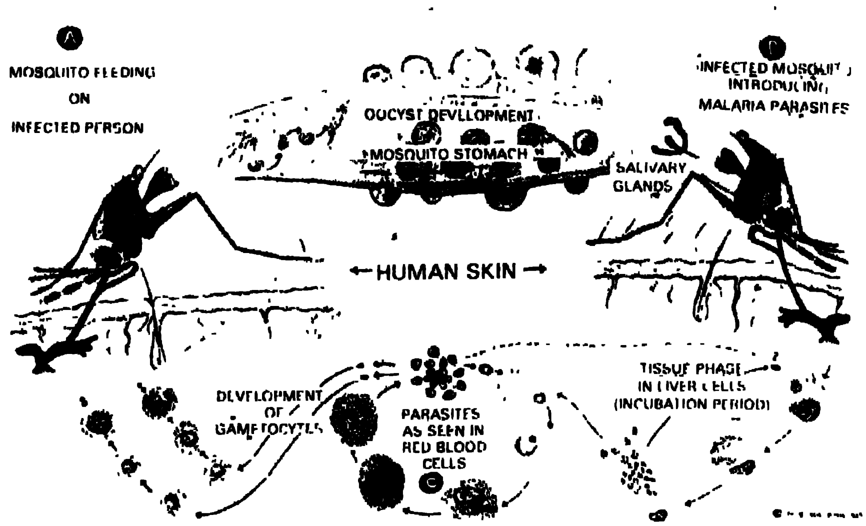
The best way to deal with the threat of mosquito borne diseases is strict observance of personal protective measures aimed at minimising risk of mosquito bites, combined with mosquito population reduction in our houses and immediate environs And an insistence that the civic and health authorities improve sanitation, including proper disposal of sewage and waste water

Contrary to general belief mosquitoes do *not* breed in filth In summer, the female mosquito lays her eggs, 100 to 250 at a time, on the surface of every imaginable occurence of still, stagnant or slow moving waters which may be as little as a cupful or less, a hoof-print, pool, pond, lake, rain water collection, drain, water channel, uncovered sewage or a bank of a stream She finds man made containers of any size or type, pits, depressions, boats, garden tanks, overhead tanks anything that can hold water, particularly in or near human domiciles, most suitable for egg laying

In favourable conditions tiny larvae or wrigglers hatch out from the eggs in two to three days They feed voraciously on particles of organic matter in the water and become plump, non feeding comma shaped pupae in the next four to six days After about two to three days adult, winged mosquitoes emerge from the pupae usually hiding or resting in vegetation or dark cool places during most of the day It is only the female mosquito that bites and sucks blood from humans and animals, she needs protein from the blood meals for egg-production and maturation For survival alone she supplants her protein diet with vegetarian diet like her male counterpart who feeds exclusively on plant and fruit juices and flower-nectar

Mosquitoes can be killed, or their life-cycles interrupted in the three aquatic stages (egg, larva, pupa), or

LIFE CYCLE OF MALARIA PARASITE



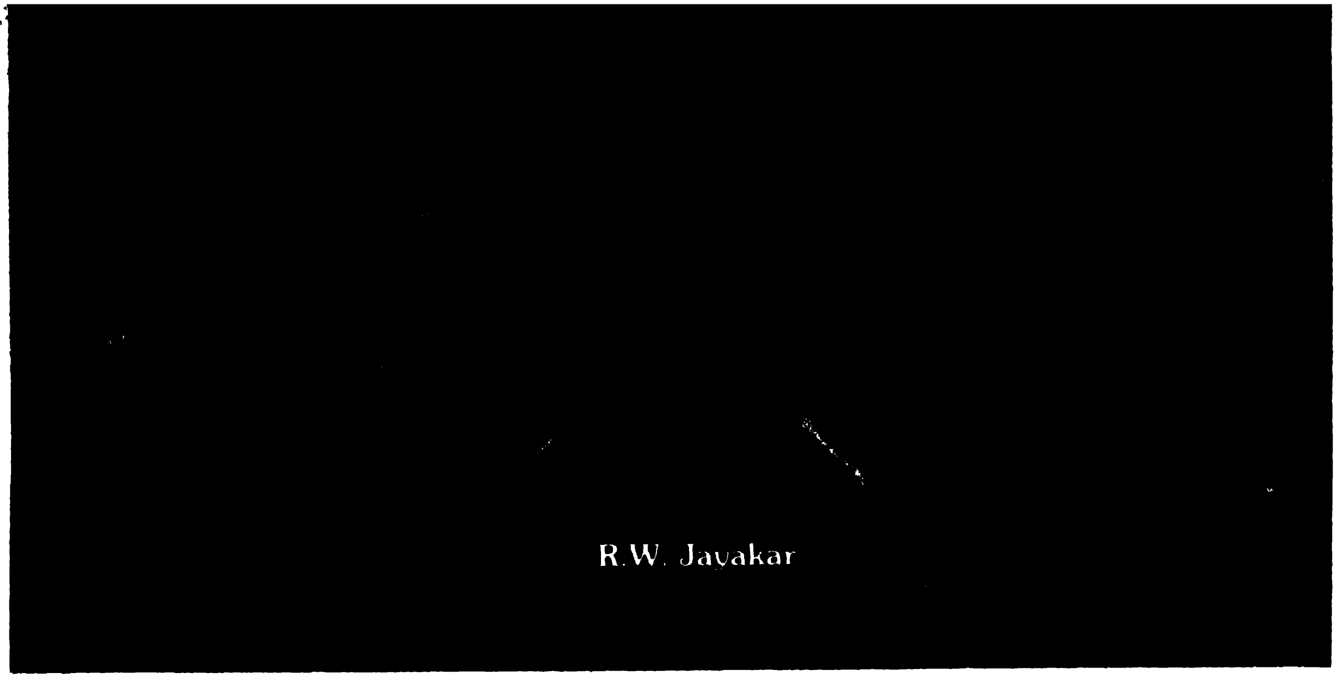
they can be prevented from breeding by filling up water collections or emptying them once a week, or applying insecticides or a thin layer of oil film on the surface of water collections which are not likely to dry up within a week The aquatic stages cannot survive without water or without air which the oil film cuts off To reduce mosquito population, we cannot possibly empty, or oil, or fill up all potential mosquito breeding places in our close environment but we can certainly deal with domestic mosquito breeding places in our home, the roof-top (water tanks) and in the compound

Aim at interrupting the mosquito-life cycle which is completed in about 8 to 11 days Get rid of or renew any and every water collection which can last a week or more Some examples are desert cooler tanks, refrigerator defrosting effluence trays, all water containers (cans, tins, drums, earthen pots), broken pots and pot shreds, coconut shells, junk piles, old tires, disused plastic, wooden or metal boxes and containers, plastic bags, and things which accummulate rain water Discarded water may contain aquatic stages of mosquitoes and should, therefore, be thrown on dry ground to soak or evaporate To be really effective and fruitful, these measures which require only a few minutes, should be a weekly dry-day drill or a habit

Adult winged mosquitoes can be killed inside rooms and buildings by spraying insecticides *correctly*, at dusk and dawn Doors, windows, ventilators and other openings of the accommodation should be kept closed during spraying and for about 20 minutes thereafter to make 'flitting' effective. Spraying in the open or well ventilated rooms serves no useful purpose as it briefly repels mosquitoes but does not kill them A bout of fever should always be treated with suspicion Your blood should then be examined for malaria parasite, filaria worms or viruses to ensure prompt and proper treatment Such care and timely treatment reduce the risk of spread of diseases to your family and neighbours

Narinder S. Narang

Mr Narang is involved in health education programmes in Punjab


R.W. Jayakar

At its simplest level the process of micrographics involves the reproduction of familiar objects in miniature Examples are the score of elephants carved in ivory in a devil's eye and the grain of rice on which is incribed the Bhagvad Gita Micrographics has a long history archaeologists have found excellent micrographic records left behind by the Assyrians at Ninevah over 5000 years ago; these are "tablets"--small hexagonal cylinders of clay inscribed with cuniform characters so small and so perfect that they could only have been made with the help of an elaborate device

The method

This method of condensing knowledge is hardly new to India Although the ancient Indians largely relied on oral tradition to desseminate knowledge the convenience of carrying a large *condensed* fund of knowledge was not lost on them Towards that end they employed abbreviation—what are our *shlokas* and *sutras* but distillates of vast oceans of learning?

However, the essence of modern micrographics is the production on a Lilliputian scale *exactly* what exists as a Brobdingnagian object Even more important is the reverse operation--the regeneration of the giant image from its micro version The need for this began to be acutely felt only with advent of printing and the enormous growth of communication following the Industrial Revolution. To handle the overwhelming flow of information the physical methods—of actually incising large originals into their mini versions laboriously by hand—were no longer adequate

It is in the 1830s that micrography was really emancipated—by two almost simultaneous developments One was in optics, the adaptation of the camera obscura; and the other was in chemistry, the production of the emulsions sensitive to light The marriage of the two resulted in photography which began to be used as the principal means of micrography (After all, the image you see on the viewfinder or the image you obtain on the negative is but a "micrographed" version of the real objects before the lens)

This marked the birth of micrographics as it is known today. German, French and English "gentlemen" began selling microphotographs as curios—in rings, in tie pins and jewellery The craze followed its logical course from objects to photographs, to documents Among the first documents to be micrographed was also the most commonly used—the Bible! One had now a choice of Bibles per square centimetre!

The power of the technique was suddenly enhanced in 1940 with the development of extreme resolution photographic emulsion plate apparently for astronomy Micrographics now took to the air. Supersecret miccographics began to travel by Pigeon Mail, V-mail, Airgraph-and underground-superspy secret microdots during the World War II The Aerogramme so widely used today was designed during the World War for microfilming letters from Europe to America Upon receipt in the US the microfilmed letters were enlarged to legible size by automatic machines and delivered by the normal postal service. Document micrography began to gain pace fast It became invaluable to the researcher because it made available for his private study duplicates of originals out of reach either because of rarity and price, distance and time A reel of structured text on microfilm could help students too It freed the teacher from step-by-step guidance He could thus devote more time to real teaching and solving difficulties To keep pace with the information explosion caused by electronics and computers after the war, document micrography had to be speedy, both in storage and retrieval Machines had to photograph hundreds of documents in a minute, retrieve any single document out of the thousands in seconds and provide "hardcopy" in a minute to the user

As is well known, the seeds of many scientific and technological innovations were laid in Europe; however, their commercial applications have flowered in the new land—the U S A This is also true of photography and micrographics It was not the snap-shot camera but the development of roll film on daylight spool that made photography so popular. In Europe, pictures were still recorded on a single-

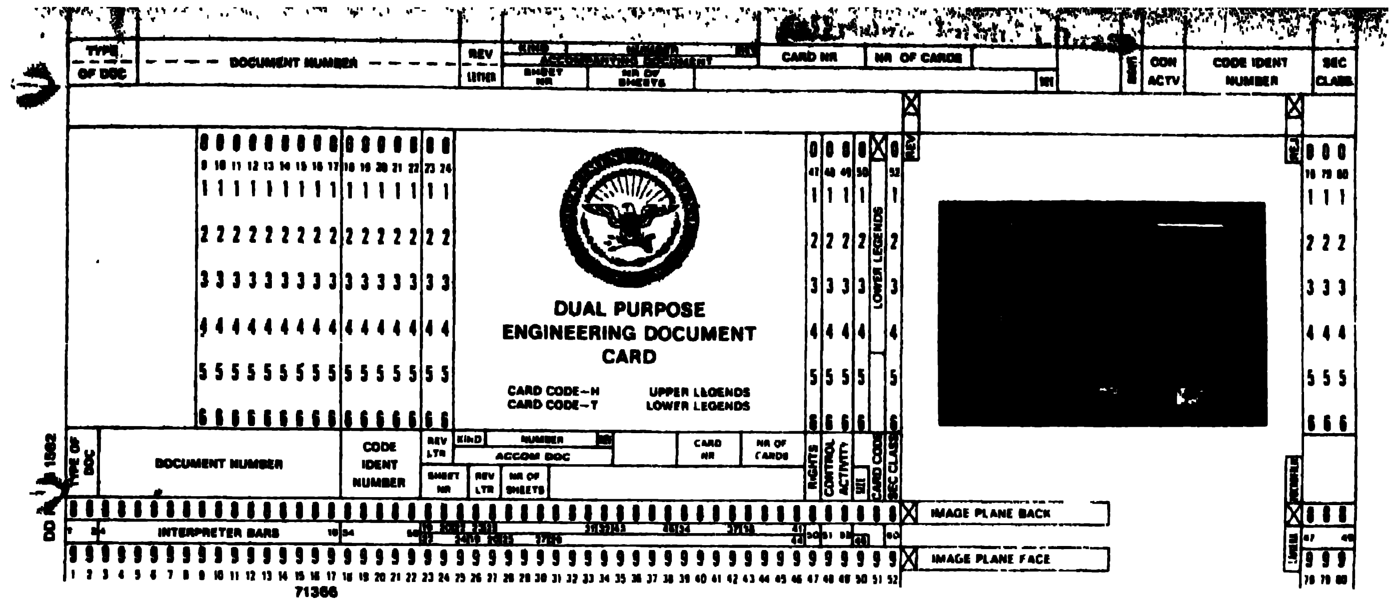


plate or sheet of film But in the US a roll of film was used in the first rotary (or flow type) microfilm camera for recording cheques And the method of recording identical photos on a sheet of film was at first used for printing textile designs, labels and later for the production of transistors and other semi-conductor devices

Initially, micrographics systems were aimed at preservation of records and space-saving Yet, the psychological resistance to scan reading matter on a screen persisted Obviously, the generations brought up to study information in black and-white on a board or paper could not come to terms with information painted with light on a viewing screen. For them, day-to-day use of viewing information on a screen was inconvenient.

With the spread of cinema and T V a whole new generation has been brought up in U S A. and Europe which is familiar to the viewing screen The advent of computer games, made the viewing screen "user friendly" even more. In India, too, with the spread of the national network of T V and the rise of computers, generations comfortable with viewing sceens are bound to come up. Once that psychological barrier is crossed, the fledgling technology of micrographics (with a viewing screen which is necessary) is sure to flourish. For it is easier to operate and more economical compared to the electronic information technology now advocated in Europe and U.S.A.

Today micrographics is changing from its traditional role of preserva-

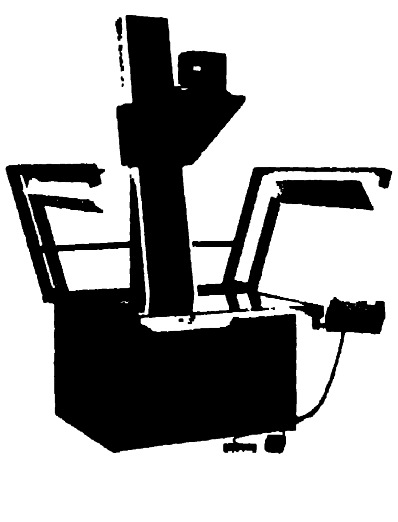
	Powers for two	Value of digit	Present or Absent	Remainder	Blip: Small date 15	Blip: Medium month 8	Blip: Large year 1947
Date (15)	3	8	Present	7	□		
	2	4	Present	3	□		
	1	2	Present	1	□		
	0	1	Present	0	□		
Month (8)	3	8	Present	0		□	
Year (1947)	8	1024	Present	923			□
	7	512	Present	411			□
	6	256	Present	155			□
	5	128	Present	27			□
	4	64	Absent	27			■
	9	32	Absent	27			■
	3	16	Present	11			□
	10	8	Present	3			□
	2	4	Absent	3			■
	1	2	Present	1			□
	0	1	Present	0			□

tion and space-saving to day to-day active use It is linked to computers for rapid access and retrieval of a store of information which is bigger than the memory capacity of a computer

Computer Assisted Retrieval (CAR), the linkage or roll microfilms to a computer basically depends on the blips in a binary code While computers work on electricity, microfilms employ light Some provision therefore, has to be made in the microfilms to transform light signals to electricity-photoelectricity Light falling on some objects gives rise to electrical charges Electrical instruments can be made to detect the magnitudes as well as the presence of an impulse of light, but if they are only required to detect the presence, the chances of error and the trouble entailed are reduced Microfilms are viewed by light, so absence of light by blocking it in patches (blips) can be used as a counting mechanism, as a numerical signal

Now any whole number can be analysed into *binary digits* by successively subtracting decreasing powers of two, for example, given below is an analysis of the date 15-8 1947 into powers of two

The table on pq.41 shows that any number can be depicted by a blip code The presence of each digit may be indicated by a white area and its absence by black Successive numbers of frames in a roll of microfilm will have a unique string of whites and blacks (blips) which can be counted by a single optical fibre in the track of small, medium and large blip. This probe of the optical fibre is located in the film gate of a microfilm reader or reader printer so as to count the string of whites and blacks on one edge of the roll of microfilm outside the picture frame area The string of whites and blacks could be of different sizes, on both edges and between the frames to expand the series of numbers, with millions of combinations each uniquely representing a frame on a roll of microfilm Then there is added help from the numbers recorded by the side of each frame in the camera itself.



Universal microfilm camera

The manipulation of binary coded numbers lies in the domain of computer programming and generation of an index by unique digits belongs to the science library classification, both are outside the scope of this article These days systems of binary coded blips are increasingly used for retrieval of microfilms (both roll and fiche) by a computer The process in known as Computer Assisted Retrieval (CAR)

The main purpose of micrographics is to make photographically reduced images of the documents within certain parameters The photographic images do have quality standards for faithfulness to the original in geometry, detail, clarity, reproducibility both in its own kind and the enlargements or reductions All of this achieved with speed and economy with due regard to the quality standards, time and again, every time and for a long time

A camera with raw films, a reader and a reader.printer are the minimum basic equipment for micrographics The camera to photograph the documents can be rotary (flow type), flat bed (planetary), step & repeat (for fiche) and COM (Computer Output Microfilm) A machine to develop, fix, wash and dry the exposed microfilms is useful for inhouse service A reader to scan the output from the processor and a reader-printer to give hardcopies is helpful Instruments for tests and controls are densitometer, microscope, rewinds, methylene blue test kit, etc

The raw microfilm is a photosensitive material on a flexible support, it may be silver-halide in gelatin, dry silver, photoplastic (vesicular), azo dyes or photo-static (xerox type) Corning developed photo-chromic glass for special applications. Of these, only the silver-halide in gelatin, though costly in price, use and storage, has found favour after extensive tests in grade one micrographics; and it is the material of choice recommended for archival storage of precious documents. It is not yet made in India (but is available to actual users on Open General Licence). It comes in unperforated 16mm, 35mm or 105mm width and in lengths of 30 metres, 40 metres, 60 metres or more (depending on the thickness of the film) for use in rotary, flat-bed and Computer Output Micro film cameras and in packets of cut sheets of size 105mm X 148mm for use in step & repeat cameras, and in premounted aperture cards for use in the cameras for engineering drawings Small rotary and flat-bed cameras cost less than step & repeat and COM cameras, but their running costs are high, while the running costs of step & repeat of COM cameras are low

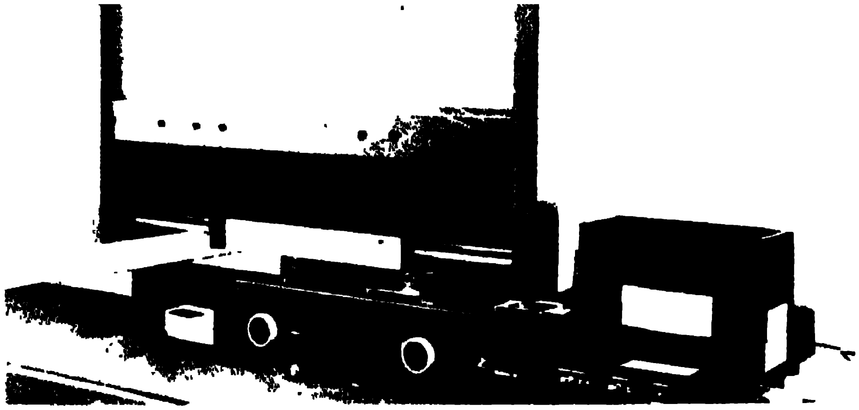
Before microfilming, crumpled, stained and torn original documents have to be made ready for the camera by arranging them in an array and sequence suitable for retrieval It is better to group all the documents of one kind of reflectance in a batch or sequence for giving uniform densities in the microfilm Simple library classification methods are useful where the output is low For large output CAR is to be preferred The camera which is to photograph the documents has to be calibrated and maintained so as to give uniformly consistent exposures on the silver-halide in gelatin film not only for that batch or sequence but for all times during the operation

Processing· The uniformly exposed silver-halide film is to be developed, fixed and dried in the processor The built-in filters and thermostats are a must for today's microfilm processing

machines which give a finished roll in ten minutes. To avoid scratches the process should use recessed rollers and film guides so as to leave the emulsion side of the film untouched The water input should ensure washing away of residual chemicals, in particular hypo which should be less than 0.7 microgram per square centimetre ... the processed film

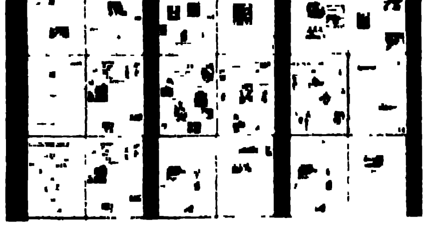
The first generation master negative microfilm so obtained is to be checked for defects Once the defects are rectified, it must be used very carefully and sparingly and never without gloves either for giving copies onto similar films for day to-day use, distribution or for giving hardcopies of the original documents The polarity may be the same or reversed

In the case of the step & repeat or COM cameras, the built-in mechanism shifts the sensitive film in rows and columns in the area of 105mm X 148mm, the standard A-6 size of microfiche, in steps of 5 rows X 12 columns = 60 pictures, or 7 rows X 14 columns = 98 pictures or more of the small documents upto double foolscap size Microfiche, therefore, is an excellent medium to store and retrieve documents pertaining to individual cases of income tax, sales tax, excise returns, insurance claims and investment and research papers The machine to scan the microfiche is of low cost and portable, though imported Microfiche can also be built-up by pasting strips of processed 16mm microfilm or by inserting them in the channels in transparent 'Mylar' jackets. These jackets are a great help in unitising the microforms to the size of standard A-6 size microfiche which can be updated from time to time by removing the old strip and replacing it with the current one Older systems for engineering drawings on aperture cards are now being replaced by automatic retrieval from roll film This effects considerable savings in the cost of equipment, material and time spent on making up the aperture cards from roll films A reader printer which can automatically retrieve and print any one aperture card from hundreds in a stack, is also available There is a built-in processor in some cameras which gives processed microfilm in short strips or in the form of aperture cards



Automatic aperture card hard copy system

While rotary cameras were initially designed for photographing small documents in a rapid and automatic sequence for banking operations, viz cheques, vouchers and letter head size documents, a new class of sophisticated rotary and small flat-bed cameras using 16mm film giving optical binary coding and numbering near each frame for Computer Assisted Retrieval (CAR) have been made possible because of the advances in micrographics



The choice of a system depends on whether the files are inactive or active Archival preservation of precious documents is best done by flat bed cameras which are designed to give high quality rolls, fiche or aperture cards Such documents fall in the class of inactive files and form less than ten per cent of the total number of documents in many an organisation Their sizes and numbers are a major factor in deciding the choice of the camera and processor The choice between in house or the few outside agencies (service bureaux) in India is to ensure quality and security A time bound programme should take into consideration the output capacity of the camera vis-a-vis that of the processor and the water supply and other raw materials

Active files Eighty per cent of the documents generated remain in active use only for six months after they have been generated Applying micrographic techniques for these documents implies retrieval methods useful during the active life stage besides long term preservation These retrieval methods add to the efficiency, saving time, they also obviate misfiling, and missing of papers, etc Clearly, the application of micrographics to these active and archival documents is worth while only where they are unmanageably large in number

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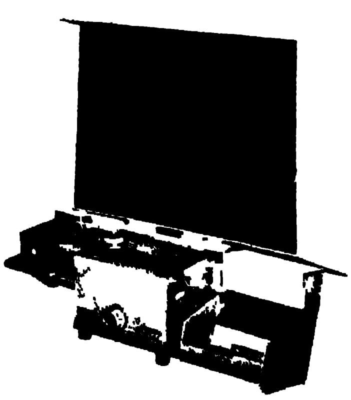
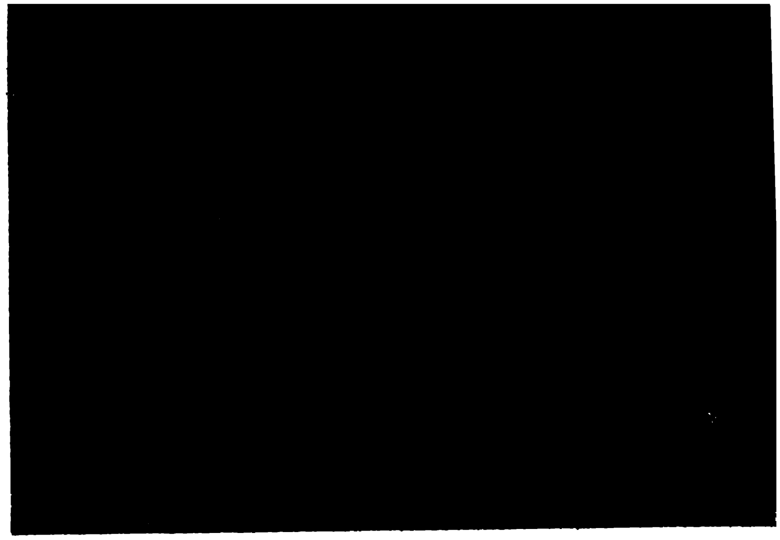


Mircrofilm reader

Resources for tomorrow

THE SYNTHETIC FUEL



PLUTONIUM has the distinction of being the first element produced artificially in visible amounts It does occur in nature but in hopelessly minute quantities So, for all practical purposes it is a synthetic element This silvery grey metal is more radioactive than uranium. It's alpha emissions could prove deadly if the metal were to get lodged in the body, when swallowed or inhaled. Since its radioactivity lasts quite long, once inside it can remain there for the whole lifetime.

Paradoxical it may seem, plutonium has been produced in larger quantities than many other naturally occurring elements, in spite of its biological hazards. The reason being, it makes an excellent nuclear fuel. It can undergo fission by capturing slow neutrons as uranium does It is the promise of plutonium to satisfy the needs of an energy-hungry world that makes it the most important synthetic element

Plutonium can be made abundantly in power reactors fuelled by uranium. The waste left behind after the nuclear fuel is burnt is, so to say, the plutonium mine The problem of recovering plutonium is, however, complicated enormously by the highly radioactive nature of the waste Plutonium mining (making?) thus involves an altogether different technology than for any other metal and mineral

Alchemy—the modern way

Alchemists of the olden times were obsessed with the idea of making gold from baser metals They worked ceaselessly with multiple mixtures of obscure materials, mostly heating them Their attempts to synthesise new elements were utterly futile as they were not aware of the key to transmutation. Their treatment could hardly touch the atomic nucleus, the compact bag of neutrons and protons which identifies an element. We know today that only by restructuring the nucleus, by way of changing the number of protons, can we get a new element

This idea was successfully tried out by Rutherford in 1919 when he bombarded nitrogen nuclei with naturally occurring alpha particles and produced oxygen in the process With the discovery of neutrons, the scope of artificial transmutation increased significantly. The uncharged neutrons were more effective in penetrating the nucleus than the positively charged alphas Then came the high energy accelerators, which provided particles with sufficient kinetic energy to disturb the nucleus The wartime activity to discover fission which culminated in the controlled chain reaction in a uranium pile came as a blessing in disguise for the discovery of new elements. Thus, in the 1940's the stage was all set for the modern alchemist to synthesise new elements in a wholesale fashion

Technetium was the first synthetic element to be created and it filled the gap between molebdynum and ruthenium in the periodic table. It derives its name from the Greek technikos, signifying its artificial or technical origin. This element was made by bombarding molebdynum with high energy deuterons.

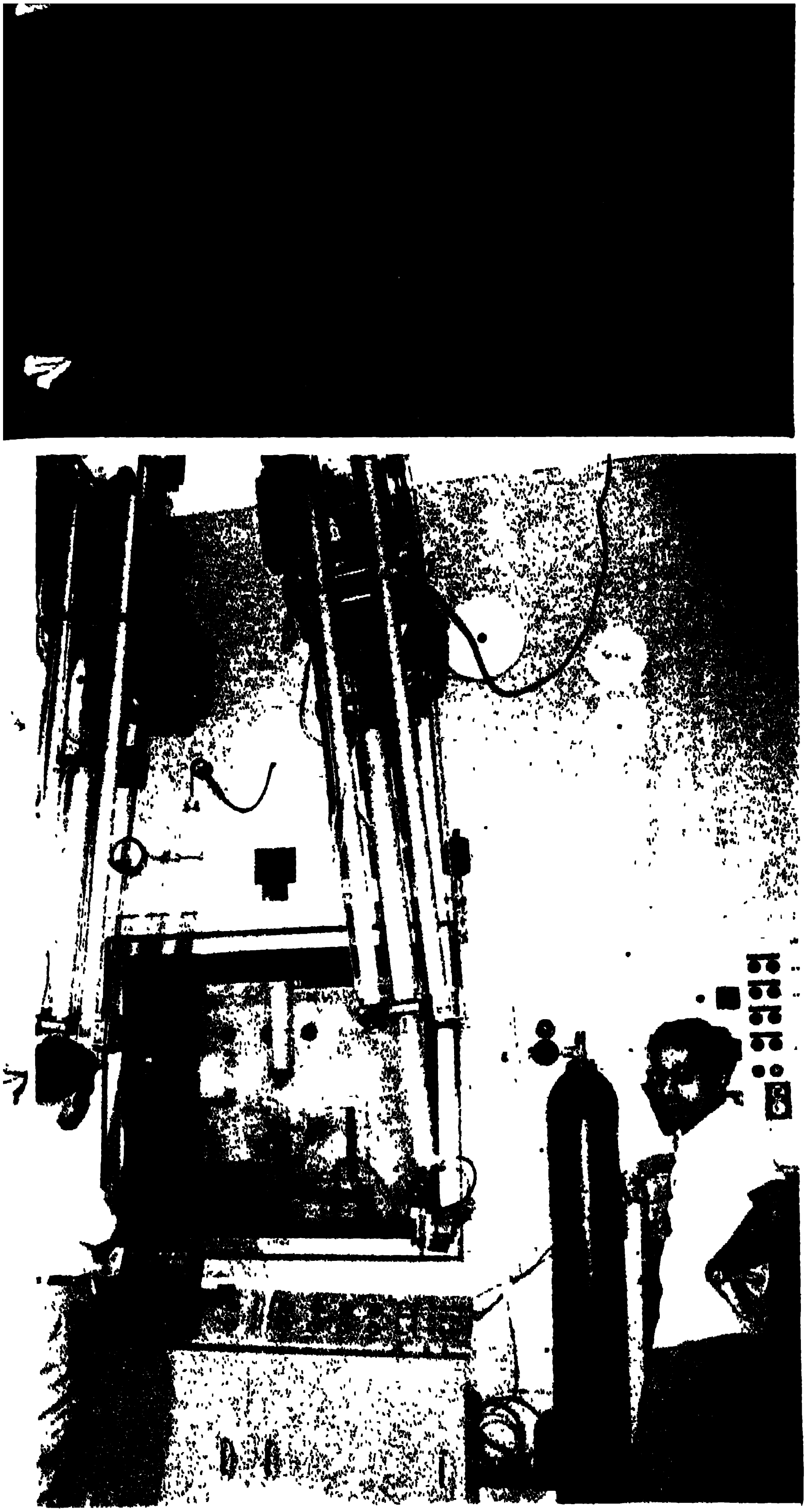
Synthesis of element 94

In an era of claim and counter-claim by different groups of scientists for the discovery of new radio elements, the work on the synthesis of element No. 94 was initiated by a group of American chemists headed by Professor G T Seaborg. During 1940-1941 they studied the nuclear reaction ^{238}U (d, 2 n) ^{238}Np and along with Np they observed the accumulation of α-activity. They could extract the new α-active substance in trace quantity and identified it as element 94 with a mass number of 238, which has half life of 86 years The new element was named plutonium after the planet Pluto. Subsequently, the isotope of major importance, ^{239}Pu was discovered in the decay product of the newly discovered ^{239}Np by Seaborg and his group.

The plutonium isotope of major importance Pu-239, as a nuclear fuel, was discovered by the same group by a slightly different route. By strongly irradiating uranium, a new isotope of neptunium was made and this decayed into Pu-239 by emitting an electron. It was in September 1942 that the metal became visible when a few microgrammes of it were made at the war time Metallurgical Laboratory of the University of Chicago Soon its most important property, nuclear fission, also came to light

Today, several tons of plutonium have been produced by several countries, thanks to the advanced nuclear technology. In thermal reactors based on uranium, plutonium is produced due to the pile reactions.

The reactor fuel contains both



The glove compartment for handling plutonium

uranium-235 and uranium-238. A slow neutron colliding with U-235 causes it to split, releasing in the process more neutrons and heat. U-235 is a small part of the fuel and the rest is U-238. When neutrons collide with U-238 another important reaction takes place, U-238 changes into U-239 and finally into Pu-239. The production of plutonium, therfore, is an inevitable consequence of uranium fission.

Interestingly, plutonium produced is also fissionable by slow neutrons. Indeed, as soon as it starts forming,it also gets burnt, though, not at the same rate. As a result, plutonium builds up in the reactor

Thus approximately one atom of ^{239}Pu is formed per fission of ^{235}U which is 0 7% of natural uranium, mostly ^{238}U. In a nuclear reactor due to various reasons, 'fuel', whcih now accompanies radioactive fission products and plutonium, has to be removed from the reactor for "processing" after small consumption of ^{235}U and recovering bulk uranium.

Plutonium separation

Separating Pu-239 from the spent fuel is simple in theory but not at all so in practice Since the fuel is highly radioactive it is first of all stored under water for cooling. During this period, lasting for several months, most of the short-lived fission products decay. The remaining long lived radioactivity makes it mandatory for all further operations to be carried out under proper shielding with remote handling All this makes plutonium processing rather unconventional.

The most popular plutonium extraction process is known as the purex process (plutonium uranium reduction process). It was developed, largely, by a group of chemists at the Oak Ridge National Laboratory, USA. It is a solvent extraction process and an organic extractant tri-n butyl phosphate (TBP) dissolved in an inert solvent like kerosene is used to extract uranium and plutonium from their nitric acid solution. To start with, the reactor fuel containing uranium and plutonium is dissolved in nitric acid and adequate nitrite is added to

convert plutonium to its fourth oxidation (valency) state Uranium and plutonium are then extracted from the aqueous phase by TBP in the extraction column, leaving most of the fission products in the aqueous phase Plutonium is then reduced to its third oxidation state and is thereby removed from the organic phase by dilute acid leaving uranium in the organic phase Uranium is then stripped back to the aqueous phase This procedure is repeated and ultimately plutonium is purified by the ion exchange method

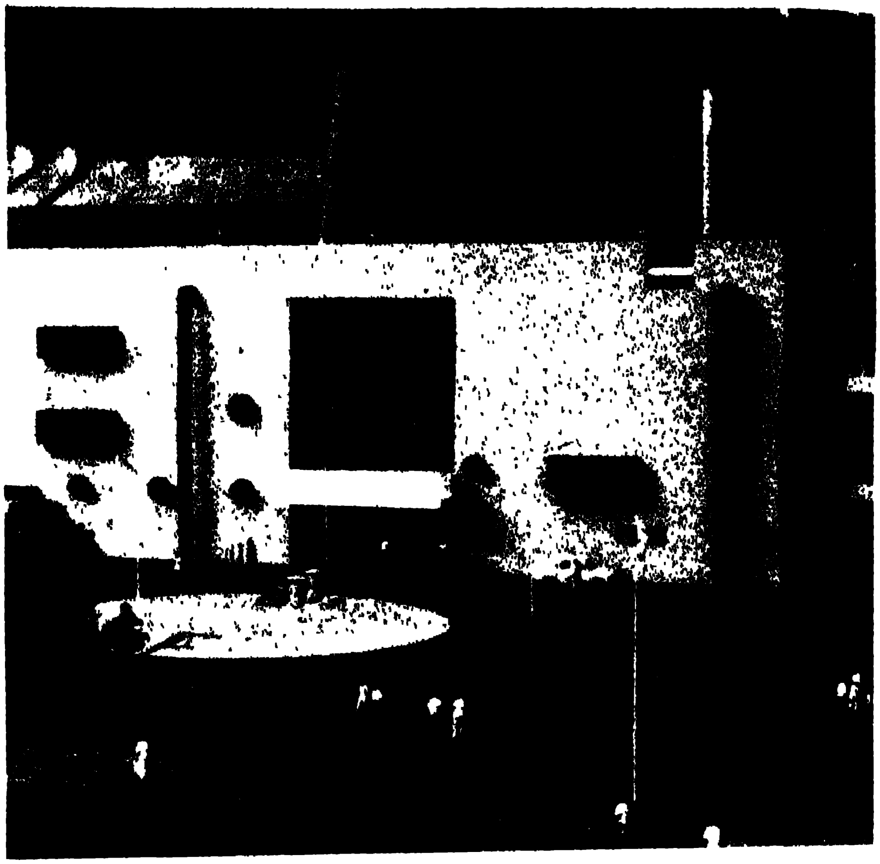
Since separation involves redox reactions, these have been thoroughly studied by many, including Indian scientists A number of problems are encountered in the separation of plutonium and uranium as both are radioactive

Hazards of handling

Handling plutonium metal is tricky as it can catch fire in air It needs to be handled in an inert atmosphere, say of argon. Plutonium oxide used in fuel does not pose such problems

The radioactive properties and the biological effects caused make plutonium one of the most toxic materials to humans It has been estimated that more than a hundred million alpha particles are emitted from a milligramme of Pu 239 in a minute The external hazard due to the alphas is negligible as they are stopped by the skin But inside the body the permissible amount is extremely low and more than half a microgramme is unsafe

However, thanks to the excellent control measures developed to handle plutonium, contamination problems are almost non existent in spite of the large quantities of it being handled



The plutonium plant at the Bhabha Atomic Research Centre, Bombay

Special facilities

For any plutonium work, a conventional chemical laboratory is not adequate Plutonium research is carried out in specially made steel boxes called glove boxes It has compressed air and exhaust air ducts and leak tight electrical lines The toxic gases evolved in chemical operations are passed through a filter along with air in the exhaust line The exhaust duct ends in the centralised filter house from which only relatively clean gas is exhausted out through a tall chimney to the atmosphere The purpose is to isolate the radioactivity (air borne) in the glove box itself

All chemical operations, heating, passing current etc, on plutonium solutions have to be carried out in the glove box The transportation of materials to and from the box is carried out via a transport chamber with two doors, in the glove box The glove box is kept at a negative pressure so that any small leak cannot spread the radioactive air Working with glove box and handling with gloves is not only tedious but also very uncomfortable particularly in tropical countries Therefore, the laboratory must have good airconditioning and ventilation systems

In India we have these facilities at the Bhabha Atomic Research Centre The maintainance of a plutonium laboratory is expensive Unfortunately there are no short cuts Round the clock air borne activity measurements are part of the safety regulation Besides, radiation safety personnel must be available all the time to safeguard the personnel working in such a laboratory

Plutonium compounds

A considerable amount of information has been obtained on the various compounds of plutonium in a relatively short time after the discovery of the element The metallic plutonium is 'grey' in colour and pyrophoric in nature It forms carbide, nitride and oxide and hydride The stoichiometry of the binary compounds are difficult to maintain and mostly results in the non-integral ratio like $PuH_{2.97}$ $PuH_{2.89}$ or so Of course solid compounds, plutonium carbide and oxide particularly, are important for their use as reactor fuel

Uses of plutonium

In various research programmes of physics and chemistry, a low flux neutron source is required Such a source can be prepared from plutonium and beryllium and is known as (Pu Be) neutron source. The source is encapsulated to permit handling in laboratories without danger of radioactive contamination Such a source can easily give 10^6 to 10^7 neutrons per second

Today, the horizon of synthetic elements is greatly extended due to the use of plutonium or other elements derived from it Thus when Pu_{242} is bombarded with ^{22}Ne by a high energy particle accelerator, element No. 104 is produced. Similarly, by bombarding Amerecium with neon Nielsbohrium, No 105 is produced These synthetic elements are also known as 5f elements Their chemistry and nuclear properties are of significance to chemistry in general and nuclear structure in particular

In India very recently a variable energy cyclotron has been installed in Calcutta where the facility to bombard suitable target material with energetic alpha particles (up to 80 MeV) is available for doing research in nuclear physics and chemistry, radiation chemistry and material sciences

Though a nuclear power station with plutonium fuel (PuO_2) or mixed oxide fuel (mixed with UO_2) is not yet popular as it needs various technological developments, such efforts are being made in USA, Japan, some European countries, and perhaps in India too

Because it is highly toxic and also catches fire in air, plutonium work cannot be done in a conventional chemical laboratory. It is carried out in specially made steel boxes called glove boxes

Lal Bahadur Shastri unveiling the plaque at the inauguration of the plutonium plant

The solution chemistry of plutonium is rather unique It has the five distinct oxidation states (from III to VII (alkaline medium only) Of these, four oxidation states can exist in equilibrium in solution, which make the chemistry of plutonium both enchanting and complicated These oxidation states in solution have their characteristic colours which again depend on the concentration of the particular ion. The most important compounds of plutonium are plutonyl nitrate and plutonium nitrate which are encountered in fuel reprocessing For plutonium metallurgy plutonium hexa fluoride (PuF_6) is important and the preparation and properties of this compound have been well studied

Auto radiolysis

Because of the emission of α particle radiation from plutonium it may also involve associated radiation chemistry It has been estimated that from Pu^{239} about 1 4 · 10^8 α particles are emitted per minute per milligramme of plutonium Therefore gramme quantity of plutonium in one litre of solution will cause significant radiation chemistry This aspect is quite important in plutonium re processing with respect to the radiation damage of organic solvents both by fission products and plutonium

Plutonium in nature

Strictly speaking, plutonium (Pu_{239}), though a synthetic element, can be found associated with uranium mineral But the amount is only symbolic It is produced in nature under the effect of natural neutrons which are emitted mostly by the interaction of alpha particles with uranium

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Britain, Australia and France are able to arrange "wombs-on hire" for fees of $18,000 to $25,000

But suppose the children die after birth; who inherits their legacy—The surrogate mother? The Doctors? Or the State? And if the doctors decide not to thaw the embryos, can they be compelled by the Court? The questions are without precedent How difficult it is to resolve them can be seen from the response received by an Australian TV station that telecast the dilemma 9,000 calls came from people who were in favour of destroying the embryos However, 7,000 others pleaded for their "life"

While the controversy rages on in Australia, the issue has already been "settled" in Great Britain The Warnock Committee, set two years ago to grapple with just such questions, says in its recently published report (June 1984) that "embryos not in utero at the death of the genetic father should be disregarded for the purpose of inheritance and succession"

The report also says that there should be no rights of ownership in embryos but only a "right to use and disposal" This should pass to the survivor if one of the genetic parents should die and to the storing authority if both die In default of agreement between genetic parents the storage authority would again step in In any case, frozen embryos should not be stored for more than ten years

The committee wants the practice of AID (artificial insemination by donor), *in vitro* fertilisation and embryo donation to be supervised by a new licensing body, one with a substantial lay representation and a lay chairman The committee recommends the banning of surrogate pregnancy, with criminal prosecution of violators And most controversial of all, it allows research on embryos, but only during the first 14 days the embryo's life However, the tampered embryo cannot be implanted into a woman or another animal The kind of research to be allowed is to be decided by the licensing body

The Warnock report has been generally welcomed (except by religious and other groups like LIFE) for its temperate views As the "News and Views" column in *Nature* says "By putting the most perplexing future uses of *in vitro* fertilisation and embryo transfer in an orderly framework, the committee has helped to make the techniques themselves seem reasonable"

Yet, one cannot ignore the "Janus faced" nature of research on human embryos (the Roman god of doors and gates, Janus, is represented with a double face -one in front and one behind) On one side is the bright face with its door to utopia and advance On the other is the dark one which descends into the chamber of "concentration camp horrors"

"We are being brought to the brink of something almost like the atomic bomb The potentiality of what can be done is quite horrific," says Sir John Peel, a former gynaecologist to the Queen of England and a past President of the Royal College of Obstetricians and Gynaecologists and the British Medical Association "I must say that I have deplored the way in which my profession is prepared to shrug off its ethical and moral responsibilities they are totally disregarding the effects of producing children in these artificial ways to satisfy the wishes of an individual or an individual couple, and with precious little thought to what is going to happen to the child or the children"

That question is most crucial How safe are these new-fangled methods and what happens when a child born out of these turns out to be handicapped or "defective" in ways as yet unknown? Any attempt to answer the question (without abandoning IVF) results in a *Catch-22* situation The entire IVF process depends on research And if the technique is to be widely used, as it will be, you

The suggestion that men will some day be able to "deliver" their own babies, was made by the Head of Fundamental Genetics at University of Paris, Prof. Jerome Lejeune last year

need far more intensive research!

In the arguments so far, the tacit assumption has been that IVF is only going to be used on childless couples What if fertile couples want it too? Will that mark the decline of the so-called natural order (and that includes sexual intercourse!)

Indeed, the earliest and strongest objections to even limited use of IVF came from within Christian traditions committed to the indivisibility of sexual union and reproduction On the other hand, lesbians welcome the separation of the act of love making from that of procreation They feel they are able to exercise greater control over their destinies with the help of techniques like artificial insemination and IVF

Some people fear the "debasement" of the process of child-bearing with overtones that are decidedly "deterministic or Orwellian" They worry about a "Brave New World" in which womb-leasing has been replaced by womb requisition! Says Lady Lothian, President of the Order of Christian Unity, "If these techniques had been available during the Nazi regime, Jewish women in concentration camps would have been forced to carry 'pure-bred' Aryan embryos to be children of the Third Reich "

To this eugenic nightmare one could add a number of other nasty tricks—ectogenesis, for example This refers to the growth of the complete baby outside the womb The suggestion that men will some day be able to "deliver" their own babies, was made by the Head of Fundamental Genetics at University of Paris, Prof Jerome Lejeune last year According to the learned Professor, one does not actually need a womb to "grow" a baby A healthy placenta and a supply of the proper nutrient and other fluids is good enough!

Ectogenesis opens the possibility of "foetus factories" These would essentially be "womb warrens" churning out spare parts for transplants Tissues from aborted fetuses are already in use, for instance, children born without the thymus gland who would othewise die, can now be saved with thymus tissue grafts

One can also envisage "android assembly lines" These would turn out cloned, look-alike individuals with "socially desirable" characteristics The techniques for cloning are already available All you have to do is to divide the fertilised egg at the 8-10 cell stage Doctors would like to implant one half into the womb where it would grow back quickly to compensate for the loss of its *doppelganger*. The other half could be used for tests and checks for genetic defects Both halves could be implanted into surrogate wombs, however The process has already produced healthy lambs that can be seen gamboling on the lawns of the Institute of Animal Physiology at Cambridge

The assumption behind these chilling scenarios is that embryos are *nothing but* biological putty—to be moulded and improved upon into superior products As opposed to such dehumanisation is the view that fertilised ova are actual, not potential, people And that embryos deserve full human rights Either way, they are quite helpless and cannot possibly have a say in the decisions regarding their welfare

The way out of such a moral morass is not only to regulate the procedures stringently but also to make the consent of the parents a pre-requisite But that still does not extinguish the potential for abuse You have only to substitute the State (or Big Brother) in the place of parents

Ironically but unremarkably, in the US, it is not the "Totalitarian" aspect but the "Capitalistic" side of the embryo transfer "business" that is being fought out in the courts The matter arose from an attempt by a Chicago-based company, Fertility and Genetics Research (FRG) to patent a process along with certain instruments they had developed for embryo transfer FRG also planned to set up a nation-wide computer database to streamline the synchronising of donors and recipients on a purely commercial basis It was to be backed up by a city-to-city air courier service that would draw on a "stock" of frozen embryos. FRG has been challenged in the courts by Jeremy Rifkin, President of the Foundation for Economic Trends, Washington and author of the best selling *Algeny* His grounds patenting etc reduces the process of human reproduction to a commercialised product to be bought and sold in the marketplace

How relevant is this debate for a country like India which is expected to become the world's most populous nation with 1 5 billion souls by the year 2025? Some of our chauvinists have already devised a far simple solution to infertility instead of getting a donation of egg or an embryo for their wives they would rather get themselves brand new spouses! But jokes apart, the pressure to beget, a son esepcially, is far more intense in India The answer, however, is not the enormously expensive and technologically complex IVF process -- not at least for the average Indian (Cheaper methods of gender-rigging are being developed But these are for use in screening individuals who may inherit diseases carried by a sex chromosome They could be used for reasons social and economic In an editorial commenting on a document, *Human Procreation*, by a committee under Dr G R Dunstan, *Nature* asks "Why draw the line at gender-rigging? A farming family of a dozen daughters and no sons may be as seriously handicapped as one that is infertile So why not acknowledge that physicians should be encouraged to offer even such a service *if there are strong grounds for believing that the results would be socially beneficial " (italics added)*

We in India should be on guard to see that, Indian women are not made to bear children conceived abroad because of the proposed ban on surrogate motherhood A few years ago the proper place for such an idea would have been dystopian fiction Not anymore It only shows how far afield the horse has gone Our Victorian society has a lot of chasing ahead □

Reversal of Roles

S. Arun-Kumar R. Chandrasekar
Kamal Lodaya Paritosh Pandya
R. Ramanujam

OR centuries the world thought that the Sun went round the Earth, till Copernicus showed that it was really the other way around Computer science too has witnesed a similar reversal of roles as regards programs and data

So far, we have assumed a program to be a sequence of instructions each instruction is executed using the input data supplied After execution the output data is generated Indeed, this was the only way of looking at programs till the sixties The Copernican revolution of computer science occurred with this idea

Imagine a vast repository of data in piles and piles Think of a program as a small bug hovering on it It settles on some particular data item, modifies it and takes off Instead of data flowing through actions and getting transformed thereby, we can have actions passing through data and modifying it The DATABASE THEORY is founded on this idea

What are the implications of such a reversal? It forces us to think of data in the following terms

* Data should be described in a precise manner and also grouped in a logically meaningful way
* All the properties satisfied by the data, that is, the *relations* true about the data, to be precisely specified
* The *assumptions* made by the program about the nature and organisations of the data to be explicitly stated
* We need, lastly, ways by which a program can *locate* particular data items from the pile for modification or use

Of course, these problems had always existed and scientists had offered many solutions before databases were formulated The conventional approach was to design *file management systems*

File systems

Earlier (Science Today, April 1984), we had studied elementary notions about files A file contains *records* which have *fields*, each field being one item of data Let us take an example and explain some terminology

Fig 1 shows entries, which are intended to be the arrival and departure timings of various trains at a particular station The first entry says that the Jammu Tawi Express arrives at Surat at 00 05 hours and leaves at 00 15 hours The second indicates that Flying Rani 1 is a train which starts from Surat at 05 40 hours, while the third shows that Surat is the terminus for Flying Rani 2.

These entries are called *instances* of a *record type*, a record type simply names the attributes and the instances are the values In Fig 2, we can see that the *file type* STATION has three possible record-types Surat is an instance of STATION, while TRAIN NAME is the type, of which Flying Rani 1 is an instance

We can think of other instances of STATION, like Pune, Bombay etc, and have various files for various stations All these files together form a *file system*, which contains data about passenger train traffic in the whole of Western India

Well, what is the idea of having such a system? What do we do with all this data?

The answer lies in the *application* for which the data is used In other words, we can answer *queries* about the data in the system For example, for the query "What are all the trains that have Surat as arrival terminus?" the answer is obtained as follows "find the instance of STATION - Surat, for each instance of record-type ARRIVAL TERMINUS do print TRAIN NAME"

We have just written the *application program* for the query above, in reality, the program would be written in some programming language

Suppose we have another query "Give the complete schedule of Flying Rani 1"

Now we have to look at all STATION instances and extract any entries we may have for Flying Rani 1 That's not enough, we have to order these results chronologically before presenting them as the schedule In effect, we create another file with types as given in Fig 3 Any instance of such a file will have

* the first entry of type DEPARTURE TERMINUS
* the last entry of type ARRIVAL-TERMINUS
* intermediate entries, if any, of type PASSING

We would also like to ensure that

* in any instance of PASSING, the departure time is always

SURAT

Jammu-Tawi Exp	0005	0015
Flying Rani 1	0540	
Flying Rani 2		2230

Fig. 1 Train timings for Surat

greater than or equal to the arrival time

Thus, we have described the data, specified relations between them and stated some assumptions about possible entries. We have also assumed ways of locating instances and retrieving them.

In the discussion above, we assumed the existence of STATION instances and computed the TRAIN instances depicted in Fig 3. It is possible that we may store instances of both file types. That is, for each station we store information about passing, arriving and departing trains and also for each train, we have a file giving its route and timings through various stations. In this case, we should ensure that

* for the same instance of TRAIN and that of STATION, the departure times are identical in both files, similarly also for arrival times.

Thus, when we have *redundant* information (that is, the same data in many places), *consistency* or *integrity* constraints are very important.

So far, we have only thought of data 'lying around in piles'. In the case of TRAIN, we wanted the instances to be ordered by time. In general, data can be *organized* in many ways. This is to facilitate speedy access to data, and any particular organisation is chosen so that specific queries can be answered fast. For example, in the file STATION, we can store the data ordered by TRAIN-NAME. This would help to obtain a fast answer to a query like

"What time does Flying Rani 2 arrive at Surat?" Special techniques like dictionary search (the way you search for a word in a dictionary) can be used to answer this query fast. However, for a query like,

"Which trains pass through Surat between 15 00 hours and 16 00 hours?" we would like to store the data arranged by time. The point to be understood is this:

When the program uses the fact that data is organised in a particular way, it is possible to have better performance.

Another example where different organisations of the same data helps

There has been a Copernican revolution in computer science as regards programs and data

search can be found in the way we locate information in books. In a book, the table of contents is *conceptually* ordered, so we consult it when we know something about what we are looking for, but not the precise term. On the contrary, the index at the end of the book is ordered *alphabetically*, so we use it when we know the term, but want to find out more about it.

This is not always satisfactory. If, for some reason, we decide to rearrange the data, all the programs which work on that data would have to be rewritten. This characteristic is called *data dependency*. One solution is to introduce further redundancy: we can have many copies of the same file, each one having data arranged in a different way corresponding to a program answering a query. In our example, we would have two STATION fields, one arranged by STATION NAME and another by time.

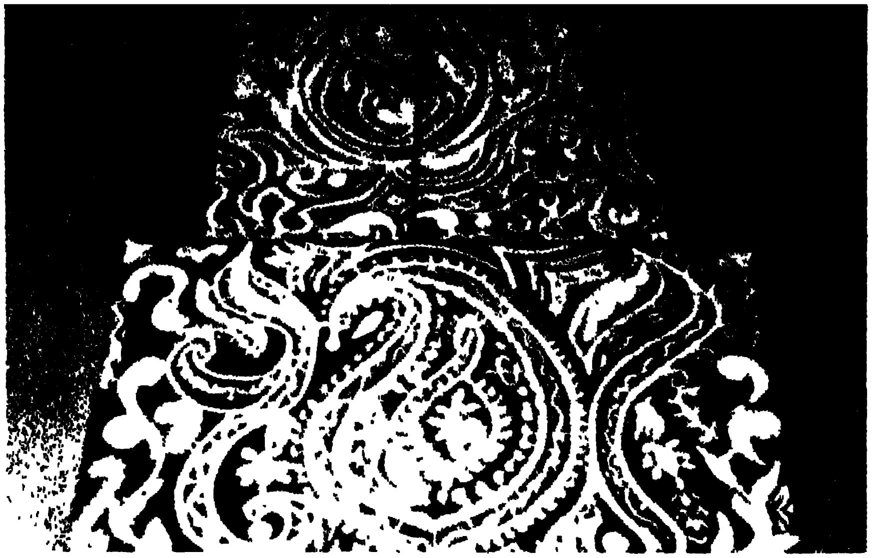
Redundancy leads to problems for two reasons:

As the number of fields increases, the number of ways of arranging the data vastly increases and for large amounts of data, this would require huge amounts of data storage area.

The more serious problem is to ensure integrity. All the files should have *identical* information. So far we talked only about data *retrieval* and this problem never arose.

The complications arise when we consider programs which *modify* the data.

To consider this in detail, let us expand our example. In Fig 4, we introduce an additional file, which contains information about the availability of seats in trains. We have greatly simplified the situation; as an exercise, the reader can try more realistic ways of describing the SEATS file including details like berths, corner seats, first/second class, 2-Tier/3-Tier etc. Also, our representation is grossly inefficient. Train names, coach numbers etc, are extensively duplicated. We will refine this definition later on.



used to mark the dots either horizontally, vertically or diagonally to make the figures perfect Perfect drawings in chalk have an added beauty when colours are filled For free-hand *rangoli*, an axis of symmetry must be taken

The selection of colours is very important in *rangoli* Either allied colours or contrast colours must be used Use of too much of dark, dull colours like grey, blue or green is depressive A cheerful atmosphere should be created by the use of bright colours such as red, yellow or orange Conversely, dark and deep colours like grey, black and blue give depth and if used sparingly give a three-dimensional effect The spreading of colours can be even if dusted through a metal tea strainer This gives a thin layer and imparts the effect of a painting, particularly when one is doing a landscape

Simple aids are often used to make extremely symmetrical and beautiful *rangoli* Traditionally, Maharashtrians and Parsis have always used metallic box like containers (*sathiya*), their bases pierced with holes arranged in different designs to decorate their portals Hard paper designs are also at times used for *rangoli* Tamilians use long, narrow wooden cylinders studded with holes in varied patterns These containers are filled with white powder and then pressed hard on the floor surface to achieve a design Colours are filled later on, either with hand or with small, metallic boxes with holes These aids ensure fast reproducibility and perfect symmetry of designs

Most of these colours are made from dyes and chemicals Some of them are organic dyes which are harmless But those made from oxides, such as red oxide of mercury and lead oxide, are not desirable Constant use and inhalation of these colour dusts may prove harmful to the lungs There may not be any health hazard when the use is limited But even then it is better to use organic dyes and prepare the colours at home. This is safe as well as economical The colours can be filled in according to the predetermined pattern One must draw the design on paper well in advance, colour it with felt pens and after ascertaining the best effect make the colours accordingly

Rangoli has no written rules and the technique has been handed down through generations It is a traditional folk art and it is very hard to trace its origin Perhaps it all started when a sense of beauty evolved in the human mind It must have been the cave women who first used this method to decorate their grottos Some of the cave paintings have sketches and designs which could be termed some form of *rangoli* According to B P Bayari, an authority on *rangoli* who has published a series of books to popularise this art, Sanskrit works like *Tilakambari* and *Kadambari* have vivid descriptions of *rangoli* and the *Ramayana* also refers to this art in various contexts For instance, while describing the cities, these works refer to the elaborate *rangoli* designs drawn by the citizens In Jain literature, the episode selection of the *Prathamunuyoga* make a mention of this art Bayan says that the epics of Jains also refer to this skill

With passage of time *rangoli* as an art has undergone several changes People have started using new media such as grains, flowers, fruits and even vegetables to match different occasions Etching in *rangoli* is again a new technique. It involves spreading of dry powder evenly and etching out patterns on it with the head of a matchstick However, in this jet age and with the advent of plastic ready-made stickers, this a is fast dying

Just as music and dance have taken varied forms in different parts of India, *rangoli* too has manifested itself in various forms in keeping with the environment, social milieu and cultural ethos of the particular part of the country While in western India it takes an extremely colourful form, with special emphasis on geometrical designs, in Bengal, where it is known as *alpana* it is drawn with wet, white liquid which is soaked rice ground finely. In the southern states, *rangoli* made with dry white powder is found in nearly every home Colour is rarely used Kerala has special occasion in *Onam* when *rangoli* with colourful flowers is made. The art is very much alive in villages of the north India where walls, rather than floors are traditionally painted with different designs

Different colours are made by mixing colourful dyes to the base of chalk, marble or rice powder There are three methods of making these colours at home, which are cheaper and brighter The first method is to mix dry lac colours with marble powder This is easy and has certain advantages—a number of shades of the same hue are obtained by mixing more colour or marble powder But the colour so made is not bright The second method is the best Here we mix organic dyes which are used to dye our clothes—not the permanent dyes but the *'kuccha'* ones easily available in market This dye should be mixed in water and rubbed in thoroughly in dry rice powder till it is fully absorbed and then the material dried in the sun We can use old, broken rice for this The rice should be washed and dried and then ground Half a teaspoon of the dye mixed in a tablespoon of water will be sufficient for one kilo of rice powder There is, however, no hard and fast rule for this mixing—it depends on the shade one wants Besides being economical, this method gives the most brilliant colours, ranging from bright orange to the deepest purple and from turquoise blue to parrot green Two precautions. Never mix the dye and powder without wearing gloves, and do not store the mixed powder until it is bone dry The mixture should be filtered through a fine sieve to get a uniform texture Such texture is needed to draw thin lines or to spread evenly There should be no moisture in the mixture, and the material must be preserved in airtight containers. The third method involves mixing of sand with colour *'kumkum'* But this is good only in the case of dark colours Apart from these, turmeric powder *(haldi)*, holi *gulal* and dried coffee powder taken out after use from the percolator or filter, can also be used.

Rajalakshmi Bhupal

Mrs Bhupal teaches rangoli at Delhi

OLD IS GOLD?

HERE are sections of population that think all that is old is gold and believe that following age old customs, in some way, is good for their health and well being. They are so firm in their belief that they will never give up the practices even in the face of most adverse conditions. They are thus credited with being responsible for preserving the culture and tradition in a society.

On the other extreme is the group of scientific minded young men. They consider everything old and traditional as being worth only for the dustbins of history. They mock at the protagonists of tradition as old fashioned "sticks in the mud" who are slaves of orthodoxy. They believe that the age old customs are meaningless and pin their faith solely in modern methods of medicine for full vigour of their health.

Where does the truth lie? Many traditional methods have been formed out of personal experience that has proved beneficial to the body and mind over the centuries, whereas modern medicine is based on the experimental method: experiment, observation and deduction. Yet very rarely have the modern methods of research been used to verify the claims of the ancient traditions.

However, now and then a research worker observes, either independently or in the course of his main enquiry, an effect of great physiological importance produced by practice of an age old custom. The observation that pulling or twisting the pinna of the external ear induces the urinary reflex in children, may be quoted as an example to prove the point.

The sacred thread and urination

It is an age old custom among a class of Hindus to wear a sacred thread over the shoulder and to wind it around the pinna of the ear prior to sitting for urination. Dr Saksena of the Middlesex Hospital in England, revealed at the International Conference of Pediatricians held in New Delhi in October 1977 that squeezing the external ear in children induces the urinary reflex through stimulation of the tenth cranial nerve. He surprised the audience by further remarking that he conceived the idea of this reflex from an age old practice followed by certain people in India, of squeezing the external ear with the sacred thread at the time of urination. It is interesting to point out that children invariably wet their clothes when their teacher punishes them by pulling their ears.

Cow dung and vitamin B-12

Smearing floors and walls of thatched huts with a paste made out of cow dung is another well known ancient Indian custom. When the paste dries up, the surface becomes hard, uniformly even and presents a clean appearance. Many people consider this practice to be unhygienic and aesthetically bad, as it involves direct handling of animal excreta.

However, there is a medical catch to this practice. It is now fully established that the all-important vatimin B 12 is synthesised in the intestines and is excreted in the faeces. Fresh cow dung contains large amounts of this vitamin. Vitamin B-12 is essential for maintaining normal health and a small quality is required to be taken each day. Deficiency of this vitamin produces pernicious type of anaemia. It is interesting to note that in Ayurvedic medicine a small quantity of fresh cow dung is prescribed to be taken in a pill form coated with jaggery for this disease.

It is obvious that folks who smear their house floors and walls with cow dung carry microscopic quantities of it on their hands and in nail beds. It is likely that they swallow this matter and unknowingly get small doses of vitamin B 12, which is so essential for maintaining normal health.

The stigma attached to the practice of smearing houses with cow dung is losing ground. More and more use is being made of the animal waste for bio gas production. Some people consider freshly voided urine as 'sterile' and use it for auto therapy. Joseph Needham in the *Cambridge History of Science in China* reveals how the Chinese anticipated the modern discovery of valuable biologically useful compounds by this method.

It may be pointed out here that in young children, however much care you may take by way of using self absorbing pads or by other means the contact of their faeces with their own skin cannot be avoided. Some immunologists consider this contact essential for the good health of the baby as, they say, it imparts a mini immunity to the body against its own matter.

Headgear and sun-stroke

India is a tropical country. The sun is hot and bright in summer. Sun strokes are sure to occur if proper care is not taken by individuals. The most effective single protective measure against sun strokes is to cover the head and the spine and avoid direct exposure to sunlight.

It is again an age old tradition, as if the ancestors had full knowledge of the important protective measure against sun strokes, to wear some sort of a head gear while going out in the open or while working in the field. Often an end of the head gear is pulled out over the back and the spinal column is thus covered. Old traditions are dying down in cities but persist in rural areas. Wearing traditional head-gear is still proudly practised by the villagers, without knowing how immensely useful it is for them in their open air life.

Continued on page 63

YOGI AND THE COSMONAUT

THE lotus pose or Padmasana adopted by Indian yogis and seers like the Buddha, is one of the most widely known postures on earth Now Padmasana has been performed in outer space, thanks to Rakesh Sharma, India's first astronaut During the joint Soviet Indian space mission aboard Soyuz T 11, the 34 year old, Indian Air force pilot turned astronaut Sharma studied the possibility and effectiveness of the yogic exercises to prevent adverse effects

When the Indian cosmonaut performed these exercises other crew members studied the activity of his body muscles and analysed the bio mechanical regimes of the work of various groups of muscles, the coordination abilities of the locomotor system and the effect of flight factors on these abilities The joint Soviet-Indian space mission carried out a lot of medical experiments

Redistribution of blood in the organism, the increased drainage of sodium, potassium and calcium salts from the body, weight loss, the shrinkage of muscles and the retarded reproduction of erythrocytes are all consequences of the adverse effect of zero gravity on man's organism, reducing its 'inbuilt safety" Scientific substantiation of the methods of preventing these effects requires a thorough and clear understanding of the processes occuring in the course of the adaptation of the system to the environment without gravitation

Scouts of zero gravity

Medical and biological investigations featured in the programmes of the flight of most *Vostok*, *Voskhod* and *Soyuz* ships Soviet science has quite a number of pioneering achievements in this field Let us recall how the duration of man's stay on board the Soviet orbiting stations grew 96, 140, 175, 185 and 211 days Nevertheless the principal limitation for increasing the stay of cosmonauts in orbit is still associated not with technical facilities but with the ability of man's organism to adapt first to weightlessness and then to the return to earth

As many as 138 people of our planet have been to space so far The aggregate time spent by cosmonauts in zero gravity adds up to about ten years This is an impressive figure Much experience has been accumulated in the process and yet weightlessness remains a mystery in many respects There are still many "blank spots" and pending questions whose solution requires major efforts, new extensive statistical data, the development of new methods and techniques to combat the negative impact of flight factors and the continuous penetration into the secrets of zero gravity's effects

The Soviet Indian crew have taken a new major step in this direction The principal objective of the crew's programme of medical and biological investigations was to study the performance of the cardio vascular system in the period of what is described as acute adaptation to weight lessness (the first seven days of the flight) It is exactly during this period that vestibular disturbances and upsets in the circulation system reduce the capacity to work because the increased inflow of blood to the head and chest area takes place with particular intensity

Special equipment

It should be noted that the *Salyut* 7 station can be compared to both a doctor's chamber and a medical laboratory It has wide ranging special equipments for registering the functions of various organs, instruments and monitors for the detailed study of the performance of the cardiovascular system and appliances for investigating the vestibular system Many of the instruments designed by Indian experts were quite important for the ultimate success of the programme

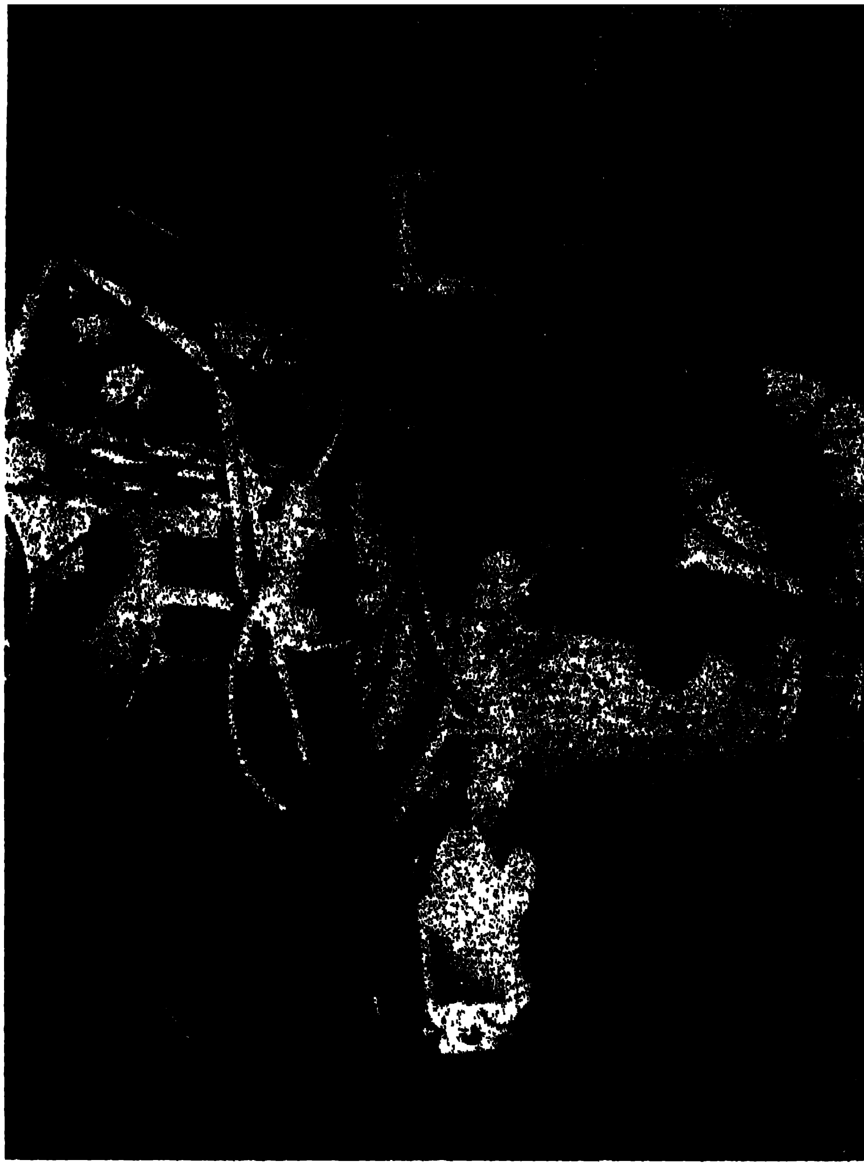
Now, what particular medical and biological investigations were included in the programme of this mission? First of all, it is the vector experiment to study the bio-electric activity and the phase structure of the cardiac cycle and the volumes of blood circulation in the flight conditions with the use of the methods of electrocardiography and kinetocardiography

Electrocardiography provides data on such cardiac functions as automatism, excitability conductivity, the blood supply conditions in the cardiac muscle and its metabolism Kinetocardiography is the registration of local low frequency vibrations in the rib cage caused by the mechanical activity of the heart It helps obtain additional information about the phase structure of the cardiac cycle and about changes in the blood supply of the ventricles at various periods of cardiac activity, as well as evaluate in closer detail the compensatory and adaptive reactions of the circulation system

Mechanics of zero gravity adaptation

On the whole, the analysis of the dyna

mics of the heart's bioelectric activity at various stages of the space flight does not only help to promptly evaluate the functions of the cardiac muscle but also provides data for the comprehensive appraisal of the effect of flight factors on the cosmonaut's organism This allows experts to understand the the principal mechanics of man's adaptation to weightlessness. The appraisal and forecasting of the condition of the cardiovascular system in spaceflight conditions are also associated with the study of the force of cardiac contractions and of coordination in the work of the right and left sections of the heart. One of the methods applicable for this task is ballistocardiography the registration of the body's micromovements related to cardiac activity. A special sensor called piezoaccelerometer is used for this purpose It is consecutively fixed in all the three planes in various parts of the body. The experiment is called ballisto 3 It yields data on the magnitude and spatial distribution of the energy of cardiac contractions and on the effect of the space-flight conditions on this distribution.



Opros experiment

The objective of the Opros (questionnaire) experiment was to evaluate the effect of various stages of the flight on the psychological condition of the crew members This condition is analysed by using a special medico-psychological questionnaire worked out by the Soviet and Polish experts and complemented by Indian specialists The questionnaire formulates five positions each of which has a corresponding mark on a five-point scale The cosmonaut chooses himself the mark which best suits his condition at the moment of the test His graded self-analysis is used to study the characteristics of movements in zero gravity, the peculiarities in the performance of familiar operations and in the formation of new working knacks, the specific features about the appetite and sleep in space, the character of interaction between the crew members, the peculiarities of their communication and so on

The Optokinex experiment provides data on the condition of the locomotor function and on the peculiarities of vestibular-visual interaction in space-flight conditions. The results of these investigations are very important for analysing the probable causes of the "locomotor disease" in space, for working out proper preventive measures and for issuing recommendations on the professional activity of cosmonauts in the course of visual observations

Anketa experiment

The Anketa (questionnaire 2) experiment was meant to study vestibular disturbances in flight and in the period of readaptation It is also used to find out the relationship between vestibular disturbances and the information obtained from the patient and others regarding his biomedical history (Anamnesis) It is a special list of questions, which the cosmonauts answer before, during and after the flight These specific questions help the crew members concentrate their attention on the dynamics of their sensations associated with the progress of the locomotor disease and figure out the relationship between their development and specific flight conditions and the nature of their activities The resultant data may be used to improve the screening and training of cosmonauts and to develop effective preventive means and measures against the locomotor disease

The results of all these investigations will help objectively evaluate the effect of spaceflight conditions on the functional state of the muscle system and of the locomotor mechanisms For the first time experts will obtain quantitative data on the performance of various groups of muscles in space in doing yoga exercises

How can these medical experiments in space benefit us, people on the earth, who are not planning to go into space? Here is just one example At least ten instruments specially designed for the flights of cosmonauts from the socialist countries under the Intercosmos programme have found application in general medicine, in diagnosing cardiovascular diseases, evaluating people's capacity to work and in clinical investigations

Yuri Gordeyev

Yuri Gordeyev is a Russian science journalist

OLD IS GOLD?

Continued from page 59

Other customs

There are many other customs which have not been probed by the scientists. Investigations of these customs, if properly carried out, hold promise of a rich dividend and may contribute substantially towards advancement of scientific knowledge. Sleeping always with legs pointing towards the North is an interesting example. It is widely practised but no one knows why. The mythological interpretation involves the direction of the home of Yama the Lord of Death. However interpretation of this practice, with a little stretch of imagination in the field of physics, is exciting.

The human body contains iron and if all of it is collected in one place, it could be wrought into two large nails. It is a known fact that, if an iron rod or a nail is hung North-South in the geomagnetic field for a long time, it automatically attains magnetic properties. The question now arises, whether the promoters of the custom of sleeping with legs pointed towards the North, had the aim of developing a magnetic field for the human body? Study of the effects of a magnetically charged body, however, fall in the field of what is now called magnetobiology.

Magnetobiology involves measurement of extremely weak magnetic fields produced by the human body. The strength of these fields is in the range of micro gauss (a gauss is the unit of measuring magnetism) and an elaborate magnetically-shielded chamber that reduces interference from external radiating sources is required for their assessment. The National Magnet Laboratory of the Massachussetts Institute of Technology in the United States has developed such a room and also a sensitive detector Squid (super conducting quantum interference device). But their work is still in infancy and nothing definite can be said about the biomagnetic field emanated by the human body.

Wearing a red mark, kumkum or tilak, on the forehead is yet another traditional Indian practice. It is now viewed as a cosmetic conceit. The effects of this practice on the body and the mind are not known and need to be investigated. However, the forehead is peculiar in many respects. The skin over the forehead is very thin and lacks sympathetic type of nerve fibres. The dilatation of blood vessels here is controlled solely by para-sympathetic nerves. The dilatation of blood vessels of the substance of the brain is also under control of para-sympathetic nerves which have a common origin along with nerves of the skin on the forehead. It is likely that stimulation of one end of the nerve fibre on the forehead elicits a reaction of the other end suggests an indirect control of blood vessels inside of the brain. The forehead is also the seat of a 'third eye' in some animals.

Fasting and dieting on certain days of the week, fortnightly or for a month in a year, is a tradition. The good effects of such a custom in reducing overweight is unquestionable. These practices have religious importance and have not been evaluated by modern scientific methods. However, it looks certain that, as the years roll by and the knowledge of science advances, the role of more and more age-old customs in promoting positive health and preventing disease will come to be recognised.

P. Shanker Rao

Dr. Rao was formerly Professor of Physiology at Gandhi Medical College, Hyderabad. He is a Ph D from the University of London

[illegible] Vishwajit [illegible]ondes finds that an [illegible] meadow has gone [illegible] thin air. What he [illegible] not know is that a [illegible] of humanoid aliens [illegible] the planet Viplava [illegible] behind this trick. [illegible] on;

Close encounters of the fourth kind

Arun Sadhu

PAMELA Fernandes was worried Her husband, General Vishwajit Fernandes, had still not returned from his morning walk Outside, in the verandah, Parikshit Bhasme had been waiting since an hour for him Although she had earlier made fun of her husband and his walk, Pamela was now worried enough to send a Gurkha orderly to look for the General But the guard watching the wasteland behind the bungalow shouted "Memsaab... General Sahib is coming..."

"Thank God!" Pamela sighed. "He is safe"

At breakfast Fernandes was his usual self, full of bluff and bluster But Pamela could sense he was upset

"You lost your way again, Darling?"

"Oh, no.. Not at all," the General smiled, "I hadn't lost it yesterday either, I am damn'd sure"

"I walked very carefully to the basin But it was simply not there, believe me Pamela, it's just gone up into thin air!"

He paused, sipped tea from his mug and looked thoughtfully out of the window Pamela's cigarette glowed Parikshit was quiet

"I was very cautious today, noted every single feature of the jungle that I know There is something strange going on As I got deeper in the jungle, it grew thicker, as if the trees had moved closer There were some patches of grass But the plain was missing! In fact, at one point, the trees were so thick and close by that I could not get through, strange, Isn't it?"

Pamela looked concerned "Vish, are you sure?"

"Nonsense, Darling, I am quite in full command of my mind and body"

"Then. how what could have happened?" Pamela crushed the cigarette in the ash tray, held one hand over her throat to control herself and touched Fernandes' hand with the other

"Listen Vish, let's, inform the area army commander here, please get him to send a squad of soldiers and find out"

General Fernandes gave a loud laugh "What's the use Nobody knows about this ground They will laugh at me .Oh, I forgot to mention one more thing, my boy As I approached what could have been the edge of the grassland, I felt a strange fragrance, very faint, but so marvellous and heady...out of the world As if it was coming from some heavenly presence there"

Pamela crossed herself

"Well, Parikshit, you *are* quiet today,"

Parikshit was listening intently He leaned forward in the chair "Just a moment, General. Let me see if I have understood you correctly," he said "As you began going deeper in the forest, it became thicker, as if the trees had moved closer Right?"

"Right"

"Good It became progressively thicker as you went along, correct? But there were some patches of grass perhaps long curved patches and on the edges of those patches the trees had moved closer still, the trees you can recognise and these you had not seen. Right? ."

"Correct ..But...but . My God . How do you know? I have not told this about those patches being long and elongated and inter-mixing of the trees how . how in the name of ."

General Fernandes fell silent Parikshit relaxed in his chair

"Well, General .. " he bagan quietly, "You know, I told you I am a mathematician I mean time and space are my special subjects .. Well, I have made certain calculations, and, if, what I have deduced is correct then, well, what you are saying must be correct..."

General Fernandes frowned, "What do you mean, boy, say it clearly"

"I mean, it is possible that the space itself at the meadow may have vanished, become invisible .. "

"Nonsense Parikshit, you are a student of science How can you "

Pamela Fernandes was speechless She found her voice with great effort and said shakily .

"What's that, Parikshit. ? Oh, I am so scared..."

Parikshit lapsed into silence He stared at the empty plate before him Pamela lit another cigarette and puffed at it furiously Then Parikshit began hesitantly

"General, I have been studying the relationship between time and three dimensional space and the fourth dimension I thought over your problem since yesterday and tried some new mathematical formulae I shall explain "

Parikshit pulled out a small thin cord from his pocket, stretched it, put it on the table and began "Now, General, Pamela imagine a tiny, two dimensional insect walking over this cord I put a blot of ink in the middle of the rope Imagine, this blot is the insect's home Now, here, I make a loop, the home is in the loop Remember, the insect is two dimensional It has no concept of the third dimension Now I raise this loop up --in the third dimension The rest of the rope is on the table The poor two-dimensional creature will walk straight on the rope It is baffled It doesn't find its home For the poor insect, the home has vanished, as if by magic"

General Fernandes looked on skeptically Pamela stared wide-eyed and neglected her cigarette Parikshit pulled a rubber balloon from his pocket

"Now let's take a three dimensional example" He blew into the balloon As it filled with air, he tied the balloon's mouth tightly He wet his thumb with ink and drew a dark circle with it on the inflated balloon. Parikshit twisted the painted circle carefully, drew it away and tied it with another thread Now the balloon had a swollen boil over itself

"The dark circle here represents your grassland in the middle of the forest As in the case of the rope, I have made a loop here see "He said triumphantly "This is the distortion of space I am talking about! We have looped out your pasture Now imagine this loop .this boil is extended into the fourth dimension... what will happen .? We poor three-dimensional creatures will not know where it has gone .We have no concept of the fourth dimension . For us, it has vanished. "

General Fernandes and Pamela stared at him with disbelief

"Now look carefully All of the painted blot has not gone over into the boil when we twisted the space Part of it has left elongated curved lines on the surface of the balloon I have not seen your jungle and the grass basin, General But I think, if we look at it from sky, it should look like the curved line surface immediately below this boil like this.. " Parikshit quickly drew a small figure on the paper

"Impossible " Pamela said in disbelief "Is it really possible ?" Fernandes asked diffidently

"If your observation is authentic, General, then this is what must have happened I have been trying to prove this phenomenon mathematically I have worked out those formulae myself...A theoretical possibility You have provided the actual proof Now my request let's first "

"Wait Wait . Parikshit . ." General Fernandes said excitedly... "My God, what you are saying if . if it is correct Its very important, my boy... very significant . . For science.. for this world why, even for military purposes.. Imagine, a thing becoming invisible. fantastic .....I know people,

Pamela spread her hands indicating space and said, "But...but...who has been twisting our space in the forest? Who...?

We must inform somebody... the military .. the scientists.... "

"No sir," Parikshit said "Let's first see for ourselves and confirm Can you arrange a small two seater plane to fly over the forest...?"

"Why not" Fernandes replied with enthusiasm "I am an honorary member of the flying club nearby Matter of fact, I discovered this basin flying over this forest."

"Let's go then..."

"Good, come, my boy...", Fernandes rose from his chair and patted Parikshit on the back.. "You know Pamy, this boy is a genius. Where did you learn all this, Parikshit? Anyway, first let me ring up the flying club We shall have lunch and then we leave for the air strip..."

"One moment," Pamela said with some hesitation, "I have a question... Parikshit, you made the loop to that rope Then you yourself twisted that balloon," Pamela spread both her hands indicating space and said, "But... but... who has been twisting our space here in the forest? Who...?

Parikshit stared at his feet

"I really don't know I can only make some guesses Can it be some natural quirk of events Or, has somebody mastered the technique of distorting the space..."

Parikshit paused He had obviously something more to say. He looked out of the window into the blue sky for inspiration

"Yes, it is possible Somebody may have mastered the technology ... someone here on this earth or may be it is some intelligent being from outside "

The crew, the scientists, the robots and the laboratories aboard the spaceship were busy at their assigned tasks Deep probe teams had to be launched outside the invisibility field for search and communication with intelligent beings on the host planet The planet had to be allowed at least one revolution (for metabolical adjustments) before any expeditions could be undertaken Meanwhile, outside the ship under the cloak of invisibility young Viplavans were playing High jumps, long jumps, running games to test responses of the body in the new physical environment

Meanwhile, groups of scientists pored over the films and data supplied by the computers The most important topic being discussed at the main table concerned life-pattern on the host planet At this table sat biologists headed by Professor Shandilya, a renowned authority on the subject Shandilya was the high priest of Viplava's scientific community A large luminous forehead topped by a snow-white mane, a drooping white moustache, sparkling, penetrating eyes, a sharp elongated nose and a transluscent expression of universal piety and love which made any stranger bow and respect the man Hemaketu, as commander, had to be there though Kalpaksha was beside him

Shandilya said, "Before going out we must review our data and observations Even within our dome and outside--they cannot see us from outside but we can see them—we have observed insects, quadrupeds of various types, some of them akin to the species on Viplava We have seen birds too, flying around our dome But obviously, the animals we observed are not the ones we are looking for I guess, the intelligent being here, the one trying to master science and technology—as is evident from our observations, the satellites, you see--should be a biped, probably, a humanoid, may be different from us, but biped certainly..."

"You seem to be pretty sure, Professor," Dr Vidyasarang, the celebrated life-scientist, gently intervened In his own particular branch, Dr Vidyasarang was on par with Shandilya, although he could not evoke the awe and respect which Shandilya instantly drew among the Viplavans Perhaps Vidyasarang lacked that universal perspective and galactic understanding which made one truly great Viplavan society was devoid of class The hierarchical chain of command, so necessary for running an organised society, was notional—with each member having almost equal status And yet, as is wont in any society, personal rivalries and petty jealosies though in subtler degrees, were not unheard of

"Well we agree that life forms evolve and advance and become more complex by a process of natural selection," Vidyasarang argued "But remember, nature has many choices at each stage of selection How can we presume that life here evolved on the lines of Viplava The intelligent being here could be a quadruped, why, even an octaped It could as well be a winged creature or an amphibian... why not? You see, three-fourths of this planet's surface is covered by water "

"Dr Vidyasarang's doubts are well-founded," said Shandilya, "But we have gone over this innumerable times. Evolution of life on a planet depends on the character of that planet, its environment, geography and countless other physical and chemical factors Only that kind of life evolves and sustains and progresses which can adopt to the environment. Nature is a rigid supervisor. Now we know that most factors of this planet are almost parallel to our Viplava and so it is safe to assume that advanced life forms here must also parallel ours Haven't we found that the bacterial forms, the insects, the flying creatures and the quadrupeds here to be akin to species on our Viplava?"

Shandilya touched his white mane thoughtfully and continued, "There is technology here, may be primitive Technology implies a developed brain And all of you know that the development of the brain is connected with multiplicity and complexity of activities Thus, an intelligent creature must have something like hands with which it can.... "

"Professor. .Prof Shandilya... wait .Look!" Kalpaksha cried out " "A living proof of your discourse!"

A hush fell on the lawn outside Everybody looked in a particular direction with awe

The forest was so thick that it was difficult to see beyond a few feet All the eyes in the dome were fixed on a small opening between two ironwood trees A curious figure stood at the base of the trunk Two legs and two hands, stuck out of the queer clothes it wore And it held a strange object in one hand

"Yes. .yes... By Galaxy! . It's a biped, no doubt," Vidyasarang conceded magnanimously

"Not merely a biped It's a humanoid, a being almost like us... Ah ., wish we could communicate with our home planet ...", Shandilya sighed

The figure had a curious-looking face - eyes, nose, mouth, ears and an ugly colour to the skin But it was human, no doubt Why, one could even understand expressions on its face It showed utter confusion It was unable to find a way among trees and looked lost Suddenly it vanished and reappeared a few feet away It was thoughtful and observing the trees minutely

"He is looking for this place .." said a voice "Poor thing... it doesn't know. .," said another "But look .Ah... it is coming..." a cry rose and all waited expectantly The figure came closer to the invisibility dome and it seemed determined to go ahead, perhaps in search of the lawn

It is a spectacular site when a biped

crosses invisibility dome The crew had observed the birds and some quadrupeds crossing it But it's different when a biped is involved

The figure nearly touched the dome Then it raised its foot to cross the dome and instantly it soared skywards It almost covered the entire dome when it put its foot across it, and landed half a kilometre away That was the magic of invisibility dome People clapped and laughed The creature was obviously baffled even more than before

"These things are probably unaware of distortion of space", Vidyasarang observed dryly

"We can't be sure," mused Shandilya "This human does not appear to be a scientist or a mathematician He may be a primitive even here Have you noticed his head? His brain is developed May be others of his species are aware of the concept "

"Good, we could observe the humanoid before we set out on deep-probe mission" said Hemaketu

"The thing loitered around for a while, wandering and stumbling in bafflement, looking keenly in all directions and then vanished back into the forest The briefing session for probe missions was to begin soon

"Dnyanamagna looked upset when he approached Hemaketu

"This thing..." he said cautiously, "call it man if you want I didn't like its coming here..."

"Why?"

"It seemed fairly intelligent We are occupying a big grass ground and it was obviously looking for it I am sure it'll bring its people here to investigate It won't keep quiet Let's get away and park our ship somewhere else, Commander."

. Hemaketu smiled tolerantly, "Don't worry Dnyanamagna. What can it do? It can't harm us, surely? We are comfortable here...."

THE deep probe squads gathered for a thorough briefing This was a historic occasion Many of those present had visited several galaxies and probed scores of planets But this planet was unique There were humanoids here, intelligent beings The probers could barely contain their excitement at the prospect of getting into this brave new world

Professor Shandilya pressed a button Three-dimensional pictures of the Earth flickered to life on a large screen behind him

"Friends" Shandilya began in an expressionless voice. "We are launching a momentous probe We are on a planet, almost our twin About 1500 light years from home Its the third planet of star X 319 in our own galaxy In Viplava's sky, you can see this star in the southern hemisphere We can't see our Sun from here because we are in the northern hemisphere of this planet Probers feeling homesick may look for a Swastika-shaped constellation during their southern forays The lowermost star in the Swastika is our Sun "

A mild ripple of laughter went through the audience This part was for the freshers, an overwhelming majority, who had come so far away from home for the first time Viplava was a society linked with instant communication systems and to be so far away where you cannot communicate with your own people was rather likely to be disconcerting for the new comers The veterans laughed, naturally

"Please don't laugh," Shandilya continued "Let's reassure the younger ones Let not the burden of 1,500 light years weigh you down You know what micro travel and micro space means When we return back home, we shall have hardly spent a few days So, do not be afraid."

Sighs from freshers They all knew about micro-travel, about suspension of fluent time and space during that travel

And yet that traumatic experience was upsetting Shandilya's soothing words calmed them

Shandilya continued, "Our main aim is probing the civilisation of the intelligent beings The probe shall examine their sciences and technologies as well as their socio-cultural-political milieu if we are satisfied we may even establish contact "

During the briefing, various images came onto the screen Scientists like Vidyasarang, Dnyanamagna, Spaceman like Hemaketu answered questions at the end of the briefing Shandilya said.

"Never before has our civilisation come in contact with other human civilisation We have come here as friends We intend no harm to them We might learn something from them and if possible we might exchange our knowledge with them "

Hemaketu explained the basic security rules

- No living thing on this planet is to be harmed
- Observe the reactions of the humans If they are panicky, sooth them or get away but don't cause alarm
- Use the force of invisibility most sparingly, as not to disturb local space on the planet
- Use the language machine Try to understand if the human wants to communicate

Dnyanamagna looked worried when the panel of monitoring scientists entered the main control room

"Hemaketu, I think we should get some additional data from outer space before we embark on the probe," he said, "for safety's sake "

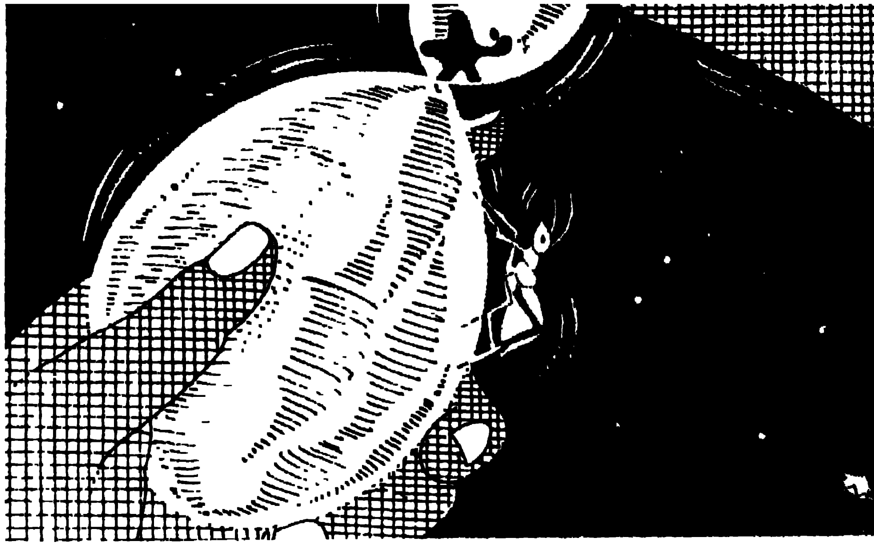
"But we can't change our programme now," Hemaketu said somewhat impatiently "Besides, we made enough observations before landing We have extensive films And what safety? We know, the planet is an ideal one Bacteria, atmosphere, oxygen.. ...."

"Not that," Dnyanamagna was thoughtful "I mean that humans.. the satellites, their technology, they worry me somehow. "

"What of that The creature seemed perfectly harmless "

"Well, they have satellites They might have flying machines like ours too. And when we go out, it could be dangerous "

"Oh, please don't worry," Hemaketu smiled, "All our probers are well-briefed "



"But if they cause some danger to us. . .?"

"I do not understand. . ."

Dnyanamagna did not know how to explain. He said haltingly, "Well, I studied that human Studied his eyes and scanned his brain through remote sensors His brain has certain disturbing concepts difficult to comprehend For example, I thought if I confronted him at that moment, he might have panicked and in panic might have used that thing in his hand to do harm. . ."

"I still fail to understand. . ."

"I think I can understand," Shandilya was listening "You mean, Dnyanamagna, that this thing would react in a manner the primitive wild life forms on our plan et react, right?"

"Right, it could kill It has violent inclinations. . ."

"Impossible," Hemaketu's eyes widened in disbelief "It is a human being, you see. ."

"Yes. . .yes. . . But we are on a different planet It has a vastly different technology, a vastly different evolution, its reactions could be much more violent. . ."

"Dnyanamagna has a point, Hemaketu," said Shandilya "I understand you find it difficult to associate this concept with a developed human But read history Pity, we stopped teaching our people the ancient history of Viplava But I remember faintly There were certain words, war. . genocide, murder We don't find them in our dictionaries I had to consult ancient dictionaries in the archives And By Galaxy their meanings are terrible Do you know what war meant? Two groups of humans attack each other with intent to kill, kill with technological inventions "

"By Universe! Unbelievable!"

"One more point of concern," Dnyanamagna said, "Our space probe reveals a proliferation of fissionary proces ses here They have nuclear energy "

"That's fine," Hemaketu said, impatient to begin the mission "No need to worry "

"But listen," Dnyanamagna said stubbornly "Apparently they have not put this technology to any use Our space films do not reveal any significant technological advance associated with nuclear energy Then what *are* they doing with this energy?"

"What, indeed?" Shandilya's face was also clouded with concern

"I guess, for destruction "

"Impossible!" Hemaketu smiled confi dently "No intelligent being can be so stupid and senseless This goes against the very concept of progress, doesn't it? I assure you Dnyanamagna, your guess is totally wrong Any way, we shall instruct our probers to observe radio silence till we recall them That will be a good enough safety measure Now come on. . . We must follow our schedule "

The walls of the large circular control room were covered with scores of video screens Each screen was assigned to the probing globes now ready on the lawns to go out into the world However, for the first 100 matras they were now to observe complete radio silence Each screen was linked with a computer which filmed all the observations of the squads, sifted the data and began instant analysis and classifica tion At the centre of the hall was a circular table behind which sat the senior scientists facing the walls Each of them had master screens to reproduce images on any of the screens on the walls at the press of a button

Excitement filled the control room The spherical globes were being tested The Sun was about to set on the horizon The forest threw long shadows on the lawns All systems were ready to go

Some commotion outside and a voice on the speaker said, "Hemaketu, please monitor the screen hundred " It showed a view of the sky from the ship's dome

Hemaketu pressed the button for screen hundred A strange object was flying directly above the spaceship It was apparently a man-made machine making an ear-shattering noise It seemed so crude and queer that many Viplavans smiled "So, this is their 'flying machine' eh?" a remark was heard amid the excitement

All doubts General Fernandes had about the state of his body and mind were set at rest when his two-seater flew across the forest He was startled to find the forest below distorted exactly in the manner predicted by Parikshit this morning Beside him Parikshit was busy taking pictures with a camera. . .

On landing they sent the film for processing and proceeded to Fernandes' bungalow by car. It was an hour's drive and Fernandes was restless.

"We must do something Oh God, Such a thing. . .can a thing vanish? Must do something "

"Yes, we must "

"But what? Look, Parikshit, I can ask the local commander to organise tank exer cises and fire on that spot. . . Or, we shall inform the military intelligence, or, better still, the space research cent . . . ."

Parikshit looked at him in surprise "Don't do that " The General was surprised by the cool authority in the boy's voice

"Look, I would go to the Prime Minister, you know. . ."

"No "

"But then, this thing this terrible happening How can you remain silent. .?"

"Quiet, General I am working on the problem . "

"Ha. . " General Fernandes hit the seat with a cle nched fist Parikshit said, "Look General, I am nearly certain that this space distortion is not a natural phenomenon It can't be, considering our orbital speed and the steady revolution round the Sun It seems to be the work of an alien power, some advanced technology Developed, may be by some intelligent extra-terrestrials . do I sound mad . ?"

"Ha. "

"But I cannot comprehend the techno logy," Parikshit continued "I am sure, we can 'prove' such a distortion mathe matically I have a plan of action But let me think first "

PAMELA was pacing back and forth in the verandah with the ever present cigarette in her lips when the car slid into the porch She did not utter a word.

They ate the lunch in complete silence Fernandes nibbled at the food. Pamela didn't touch it And Parikshit was lost in deep thought as he chewed mechanically...

Barely an hour after, when the sun struck the horizon, a motor-cycle messenger brought the prints of the photographs taken in the afternoon One picture exactly matched the figure drawn by Parikshit

Pamela was speechless She again made sign of the Cross The glowing tip of the cigarette almost scorched her fingers when she hastily threw it into the ash tray Shaking with apprehension, she looked at the forest from the window The sky above was rapidly graying And then she gasped Her eyes dilated fearfully "Vish. Parikshit..." She gave a choking cry "Look. .Look... at that . there.. "

GENERAL Fernandes' two seater flew at close range above the invisibility dome. It was easy to observe the machine and focus on the figures in it The scientists looked at their screens with curiosity and admiration

Dnyananiagna said, "Focus your screens on the figures within One of them is the one we saw this morning "

The machine vanished after circling over the dome for some time

"Well, this fellow has some doubts " Vidyasarang said

"No use he can't see us " Hemaketu said

"Did you observe the second figure?" Dnyanamagna asked "I think he was more intelligent and developed Did I see comprehension in his eyes?"

"Impossible," Vidyasarang said, "Won't believe this biped has a brain developed enough to understand concepts of fourth dimension and space distortion Or we should have witnessed a parallel technology "

"Yes And his machine . It was so laughable. ." Hemaketu agreed "Our primitive ancestors had better technology "

"Please, don't jump to hasty conclusions," Dnyanamagna said "May be, there are stratas of developmental stages May be, some other humans here have better developed flying machines "

"Well... This has been an endless discussion," Hemaketu said "Anyway, it doesn't affect our plans Let's go All systems OK?..."

The tests proceeded smoothly In barely two hours, the first globe lifted off the lawn, broke the invisibility shield and flew swiftly

on its course For the first hundred matras, it was not supposed to communicate with mother ship then, one after another, globes shot out of the dome in rapid succession, cruising on their different courses to probe the unknown world The globes were transperent and difficult to locate in the evening sky But if one looked carefully, one could see the bubble like globes coming out of nowhere like hot shells from a gun They made no sound They were the fastest moving objects to be seen by the Earthmen

THE western horizon had darkened in India In Africa and in West Asia the Sun was still high in the western sky It was mid-day in Europe and early morning in America The Western cities of America were still shrouded in pre dawn slumber It was night in Australia, China, Japan and Indo China The night was quite young in eastern India

The earthlings took some time to understand what was happening The news spread quickly When moving at top speed, the transparent balls were almost invisible But at lower heights and at operational low speeds, they were quite visible, reflecting the sunlight, shining like soap bubbles, emitting many hues in the sky Often in the dark side of the Earth, a globe would throw a powerful beam of light for close observation The figures in the inner ball looked like the pupils of an eye The globe would suddenly become stationery in the sky and in a twinkling of an eye, speed up in some other direction At some spots, they actually descended on the Earth

A young astronomy student in Bangalore had trained his telescope at a constellation He wiped his eye and put it again to the lens The thing had vanished He had seen a couple of transparent balls moving with great speed After a few moments, he saw them again They vanished in a few seconds Then again after a few minutes, a ball materialised It became larger as it neared Suddenly it changed direction and sped away He was convinced They were UFOs -Unidentified Flying Objects He rushed to a telephone

The night Chief-Sub at the Press Trust of India News Desk was busy sifting through the flood of copy He took one glance at the story and spiked it muttering, "Shit We are not a yellow rag "

Within ten minutes, another story came his first reaction was to spike it too But before that, two more similar copies came from Jalandar and Cochin He read them carefully and asked a local reporter to investigate By that time, the news agency office had begun receiving telephone calls. Hundreds of people in Bombay had sighted those mysterious globes One caller said he had seen a globe descending on the deserted corner of Shivaji Park beach There was no sound and he saw two human forms getting out of the transparent globe He didn't know what happened next He had bolted in fright

The reporter was resourceful He contacted the local air force station commander

The officer said, "Look, we have also got reports of these sightings But surprisingly, our radars do not show anything. I contacted Bangalore, Pune, Agra and they too are in a mess Off the record, we are on alert One of our Mach II saw two of these mystries and he tried to chase them No luck They were too fast Then he suddenly found that they were over his head and observing him the damn thing .."

"By this time, the Reuter, A P , UPI and AFP had also begun reporting The BBC made a scoop by showing a live 50 second sighting, the American CBS followed in moments A bedlam followed in the world Many countries sent out their superfast planes to chase the objects for some time, the objects left no trace on any of the radars But soon after the BBC telecast, thousands of radar screens all over the world showed countless shining dots Confusion was worse confounded with panic All over the Earth, people came out on the streets to watch the skies with awe. An American TV commentator shouted frenziedly, "Extra terrestrials are coming they are coming . Run for cover ... Run for your life.. "

—To be concluded

COOLING BY THE SUN

D.K. Dixit

OF all the uses of solar energy, refrigeration and air-conditioning seems to be the most tantalising. The use of solar energy for cooling purposes, whether to store food or for comfort, has a two-fold attraction For one thing, the demand for cooling is generally the greatest at times of maximum solar intensity and for another, the cooling is far more important in hotter regions than in colder climes Active solar cooling is therefore of considerable current interest the world over

In a tropical country like ours, the importance of refrigeration can hardly be overemphasised. Agricultural products play a significant role in our economy Some of the produce could yield substantial foreign exchange, potatoes and onions, for instance Steps are being taken to increase the production and export of these commodities. However, between production and actual sales, about 30 per cent of the produce is spoilt in storage and transit This alarmingly high spoilage rate calls for closer attention to scientific methods of storage

The most important method used for preventing spoilage is preservation in cold storages In 1947 there were only four cold storage units in the country while in 1972, there were 1390 This continual increase in storage capacity is still dwarfed by the growth in the production of cold storage items like vegetables, eggs, fish, dairy produce, etc In cold storages, temperatures ranging between -1 1° and 10°C are maintained, for freezer storage, temperatures below -1 1°C are required Exposure of potatoes to temperatures above 21°C after harvesting causes a high spoilage rate It is necessary to store them in cold storages at 12°- 16°C and at 90 per cent relative humidity These conditions are adequate for short-duration storage As the storage period is increased, lower temperatures are required, the ideal conditions for long-duration storage being 5°C and 90 per cent relative humidity But agricultural centres are usually far away from electrical power supply for running large refrigeration plants, and solar refrigeration provides an alternative.

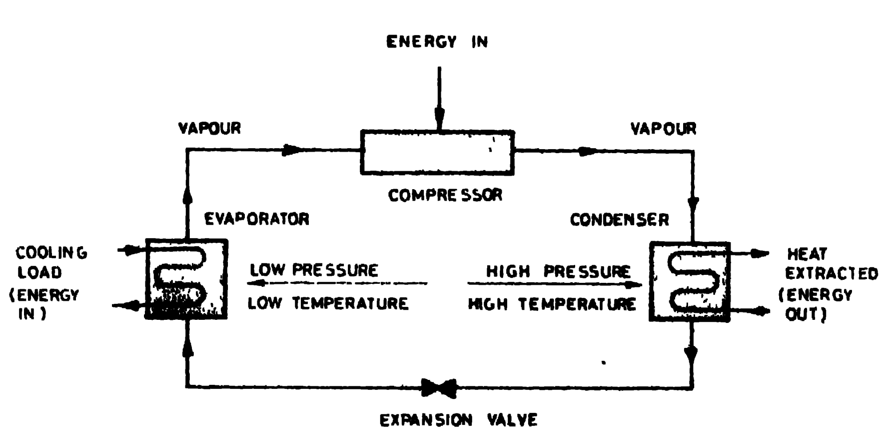
The most common types of refrigeration systems in vogue today are the vapour compression system and the vapour absorption system. Both depend on using a liquid refrigerant in which the pressure is decreased by passing the refrigerant through an expansion valve. At the lower pressure the saturation temperature is low and the latent heat required to evaporate the working fluid is taken from the space to be cooled

Refrigeration in conventional cold storages is usually accomplished by vapour compression machines Refrigeration by a mechanical vapour compression system is efficient but expensive. A relatively large amount of work is required because the vapour undergoes a large change in specific volume during compression The amount of work required can be reduced by reducing the volume to be compressed or pumped by some means One such effective alternative is the vapour absorption refrigeration system

That absorption refrigeration machines could be employed to produce cooling from solar energy has long been realised The earliest successful attempt was made by Mouchot in 1878. Absorption refrigeration originated in 1824 with Faraday who achieved cooling by vaporising ammonia. An absorption cooling system is compatible with the low-grade heat generated by present day flat-plate solar collectors (p. 19, SCIENCE TODAY, September 1984). Flat-plate collectors are normally preferred because concentrating solar collectors are more expensive and complex.

The basic vapour compression refrigeration system is shown schematically in Fig. 1. Incidentally, in all refrigeration systems, a condenser, an evaporator and an expansion valve are common components. The fundamental concepts of vapour compression refrigeration cycle are as follows. If a liquid is introduced into a vessel at low pressure, the liquid will evaporate In the process, the latent heat of vaporisation will be extracted from or through the sides of the vessel. As the liquid evaporates, the pressure inside the vessel will increase until it reaches a maximum value called the saturation vapour pressure corresponding to the temperature No further evaporation is possible after that If now some vapour is removed from the container by means of a pump, the pressure will come down resulting in more evaporation of the liquid A suitable liquid is the refrigerant and a container or

Fig. 1 The conventional vapour compression system



vessel where vaporisation and cooling take place is the evaporator. This system can be converted into a continuous cycle. To this end, the working fluid undergoes phase change from vapour to liquid in a condenser. The vapour pressure corresponding to the temperature of condensation will necessarily be appreciably more than the evaporation pressure The increase in pressure and circulation of vapour is achieved in a compressor The high pressure liquid leaving the condenser passes through an expansion valve before being injected into the evaporator at low pressure The compressor is driven by an electric motor

In a vapour absorption system, to render the cooling process continuous, it is essential to produce a means of removing the refrigerant vapour as fast as it forms In this case, the evaporator is connected to another vessel containing a substance capable of absorbing the vapour Thus, if the refrigerant were water, a hygroscopic material like lithium bromide is used in the absorber The substance used to absorb the refrigerant is known as the absorbent or carrier The next stage in achieving a closed continuous cycle is the release of refrigerant at a convenient pressure for its subsequent liquefaction or condensation in a condenser This is accomplished by pumping the solution to a high pressure with a liquid pump The solution enters the generator, where heat is added to the refrigerant absorbent combination, and the refrigerant is driven off from the solution as a vapour The carrier (lithium bromide in a water-lithium bromide cycle) after releasing its vapour is returned to the absorber The refrigerant vapour is thus compressed without the input of shaft work demanded by a vapour compression system

The water-lithium bromide system suffers from two distinct disadvantages. at low temperatures and high concentrations of the absorbent (lithium bromide), the absorbent crystallises, and since water is the refrigerant, the

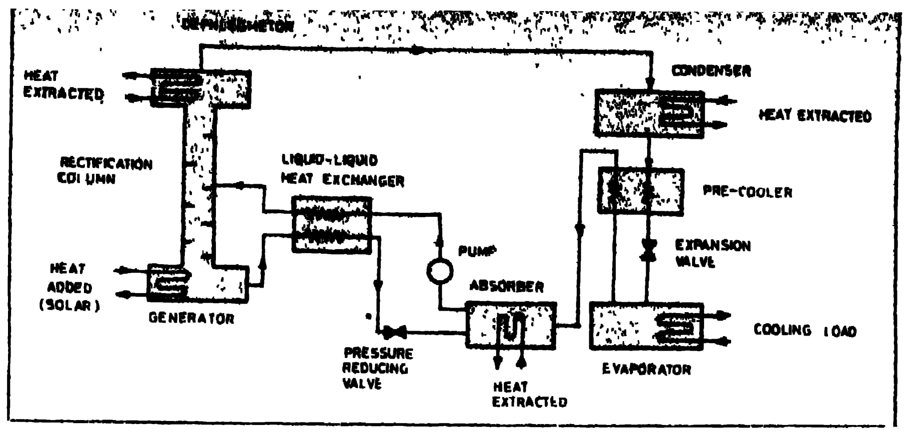


Fig. 2 The aqua-ammonia vapour absorption refrigeration system

evaporator cannot operate at temperatures much below 4.4°C The usual lower limit of temperature is 2°C in such an absorption chiller

The aqua-ammonia vapour absorption refrigeration system (Fig. 2) essentially consists of a generator, condenser, evaporator, absorber, expansion valve, solution pump, liquid-liquid heat exchanger and pre cooler. In operation, a mixture of refrigerant (ammonia) and absorbent (water) is heated in the generator to boil off the refrigerant. Water being volatile, some of the absorbent vapour will also go alongwith the refrigerant in the condenser and what will be in circulation in the refrigerant circuit through the evaporator and expansion valve is the aqua-solution rather

About 30 per cent of the agricultural produce is spoilt in storage and transit, which could be avoided by cold storage

than pure ammonia condensate To obviate such a possibility, a rectification column (analyser) is required to separate the water vapour leaving the generator as also to ensure that only pure refrigerant goes to the condenser The feed is generally at the centre of the column and a dephlegmator (reflux condenser) is fitted to provide the necessary liquid reflux above the feed plate The generator operates at a pressure high enough to enable condensation of ammonia vapours in the condenser. This condensate is expanded to a lower pressure through an expansion valve. Cooling effect is obtained in the evaporator as a result of evaporation of refrigerant at this low pressure. The resultant refrigerant vapour is then absorbed in the absorber into the weak solution returning from the generator. The solution now rich in refrigerant (strong solution) is pumped back to the generator to continue the cycle. The generator, absorber and the solution pump replace the compressor in the conventional vapour compression system A liquid-liquid heat exchanger interconnects the generator and the absorber and provides simultaneous heating of the strong solution and cooling of the weak solution, thereby reducing the amount of heat input to the generator and the amount of cooling required in the absorber. Similarly, a liquid-vapour heat exchanger, usually called 'pre-cooler', is placed between the condenser and the evaporator to cool down the condensate with the refrigerant vapour leaving the evaporator, thus improving the refrigerating effect

A brief description of other systems too may not be out of place here. The vapour compression refrigeration system itself can be combined with a solar-driven Rankine power cycle (Fig 3) Solar energy can be used to evaporate freon or water in a boiler which supplies vapour to a turbine which in turn drives a compressor.

In an open cycle absorption refrigeration system water is used as refrigerant from an external source and is evaporated under low pressure, producing the desired cooling The refrigerant vapour then passes into the absorber Regeneration of the weak absorbent is accomplished by losing the refrigerant, that is, water, to the atmosphere. The solution is heated and concentrated by water-evaporation by employing a flat plate solar collector A continuously operating vacuum pump keeps the pressure low and deaerates the solution after being exposed to the atmosphere

collector is merely a titled flat blackened surface over which the absorbent solution flows as a fluid film. The open cycle uses a simple collector and has an improved thermodynamic performance A combination of water and lithium chloride has been tried by researchers in the USA.

The intermittent vapour absorption cycle consists of two containers—condenser/evaporator and the generator/absorber—connected by a tube The system operates in alternate modes. In the regeneration phase, the container with the strong solution acts as a generator, driving the refrigerant to the other container where it condenses and is stored This is followed by the refrigeration phase in which the condenser acts as an evaporator and the generator as an absorber. The refrigerant takes up load and the vapours are absorbed by the weak solution, increasing the concentration and completing the cycle.

In the jet-pump system a convergent-divergent nozzle replaces the compressor. The primary fluid, which receives heat as input from the solar collectors, is expanded within the jet-pump thereby effecting compression of the refrigerant The desiccant systems use an evaporative cooler to produce refrigerated air Two systems, the ventilation mode and the recirculation mode, as also a modified system using an indirect evaporative cooler, are used

Essentially air is circulated through a desiccant bed which absorbs water vapour in the air, releasing latent heat Desert air (comparatively hot dry air) leaves the desiccant bed and is cooled by passing it through an air-to-air heat exchanger and an evaporative cooler The operating temperature is in the neighbourhood of 65.5°C Desiccant cycles operate with COP (coefficient of performance) ranging from 0.3 to 0.8 The COP decreases with increasing humidity (COP is defined as cooling load or heat transferred in the evaporator (refrigerating effect) divided by energy expended to effect this refrigeration or total heat supplied to

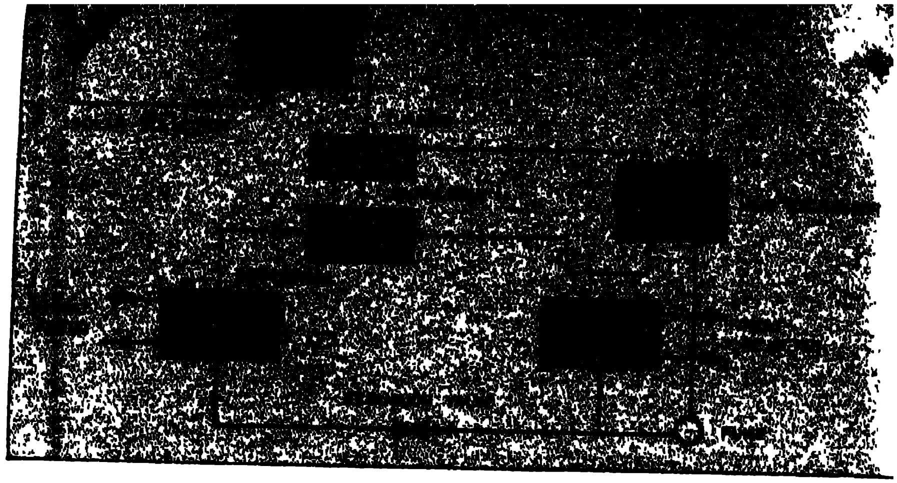


Fig. 3 The single-fluid Rankine cycle solar-assisted refrigeration system

the system. However, in solar cooling systems, especially where auxiliary or back-up energy is used, there is no unique definition of COP used by researchers in this area)

Desiccant cooling systems are attracting increasing attention nowadays. Their main advantage is that only air and water are the working fluids. Readily available materials and simple reliable components are used The main constraints so far include their low efficiency, necessitating a large heat input to regenerate the desiccant, their typically huge size and large parasitic losses The solar collector cost component being dominant, the desiccant cooling systems will be competitive only if the collector price is substantially reduced.

Hybrid refrigeration/sorption solar cooling systems also need to be touched upon In such a system, the sensible load is taken care of by a refrigeration unit while the latent load is handled by a sorption dehumidifier A higher system COP with a low source temperature is possible with such systems

For the purpose of comparison of advantages and disadvantages of the various systems, two important parameters, the operating temperature and the COP, are good yard-sticks. Any improvement in the COP can also reduce the cost of the system considerably because of the decreased collector area

Space cooling by natural methods is within the realm of possibilities The 'Sky-therm system,' as an alternative, non-mechanical, natural, nocturnal cooling-storage system, relies on night radiation and convection to cool the roof pool. As a rule of thumb, one ton of cooling is accomplished with a roof pool of about 1000 sq ft (93 square metre area). During summer, at night, the water in the pool or pond is cooled by radiation and evaporation, and during day, the insulations are moved over the roof ponds to prevent heating from above. In the 'Rock-pile system', developed in Australia, the night air cooled by evaporation is blown through a rock or pebble-bed which stores this 'cold' During day time the room's air is cooled by blowing it through this rockbed in the reverse direction

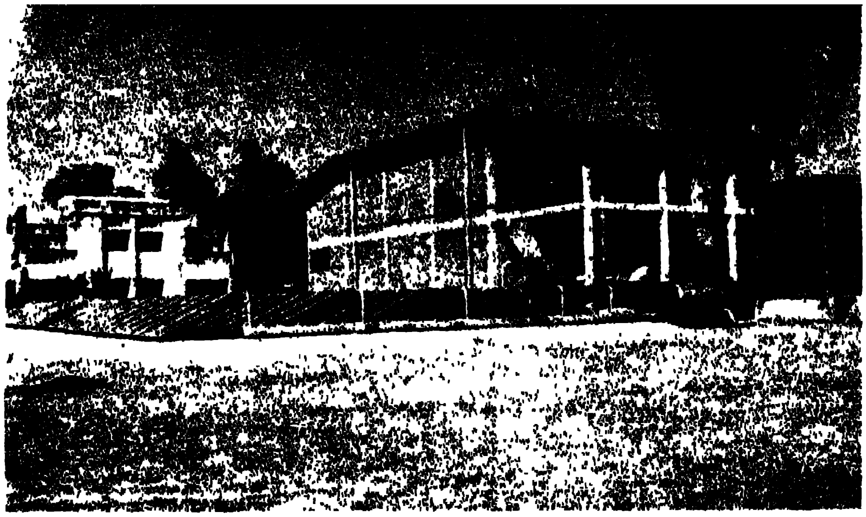
The advantages of using a solar cold storage unit working on the aqua-ammonia vapour absorption cycle are manifold. For instance, the energy supplied is essentially in the form of low grade energy, there is less wear and maintenance and the liquid carry-over from the evaporator causes no difficulties. The absorption system has some other advantages over its compression counterpart: there are no moving parts, save a small solution, pump; more compact in larger capacities; and there is less wastage of refrigerant, unlike in the compression system, due to leakage through the shaft seal.

Although a vapour absorption system operating on a water-lithium bromide cycle gives better performance than an aqua-ammonia system, its use is limited to air-conditioning since water is the refrigerant The aqua-ammonia system can be used for both refrigeration and air-conditioning. This combination gives more cooling per unit weight of refrigerant. Both the high latent heat of ammonia and pressure- temperature- concentration relationships of ammonia-water com-

bination are responsible for this. The only demerits are the toxicity of ammonia and the high volatility of water (carrier) which necessitates the rectification. Power savings to the tune of 80 per cent of the power consumption in the compression system with increased savings for longer tonnages have been achieved with solar cold storages in India A solar cold storage unit has been developed (as a project sponsored by the Department of Science and Technology, the Government of India) at the Indian Institute of Technology, Bombay. It has a capacity to preserve two tons of produce (potatoes), the temperature and relative humidity being maintained at 5°C and 90 per cent, respectively.

The unit consists of an array of flat-plate solar collectors with booster mirrors to yield hot water at 95°C, an insulated cold storage room and a refrigeration system of 0.5 ton capacity, based on the well-known aqua-ammonia absorption refrigeration cycle An auxiliary electric water heating system is also provided to take care of cloudy days. For sensible thermal storage, a tank of 5000 litres capacity has also been built

Jyoti Ltd, Baroda, has developed a compact one-ton solar-powered cold storage system based on aqua-ammonia vapour absorption refrigeration It is specially attractive for remote and rural applications with the heat input temperature being 90°—100°C supplied through hot water from flat-plate solar collectors. The power savings are almost 60 per cent of the conventional vapour compression systems. Cold storage temperatures of 0°—10°C can be achieved with a high coefficient of performance. The unit is easy to maintain with provision for non-sunshine hours using energy storage on a novel product storage concept. A 10-ton solar cold storage plant, the biggest so far, developed by the firm, was recently commissioned at Chani near Baroda by the Gujarat Energy Development Agency, and is used to preserve potatoes. Another 30-ton solar cold storage is installed at Bamnauli in UP Of late, Bharat Heavy Electricals Ltd, Hyderabad, has also developed a one-ton aqua-ammonia vapour absorption refrigeration system. Advani-Oerlikon, Pune, has also joined the fray.



COURTESY JYOTI LTD

Fig. 4 The 10-ton refrigeration solar cold storage unit (vapour absorption system) at Chani near Baroda. The structure in the middle is the storage unit. Just outside in front is the refrigeration system and in the foreground the flat-plate solar collectors. On cloudy or rainy days, a wood-fired boiler (foreground, right-hand corner) is used as an auxiliary heating system

Admittedly, the payback period of solar-powered cold storages is far too long to be cost-effective All solar systems, for that matter, are capital-intensive and usually more expensive in their initial costs compared to alternative conventional systems. For example, a 10-ton solar cold storage unit may cost around Rs 16 to 18 lakhs. The determinant of solar cooling economics will be the cost of available alternatives. 'Solarising' cold storage holds great promise and potential for remote, rural communities in the foreseeable future The Department of Non-conventional Energy Sources (DNES), Government of India, can be expected to accord priority to solar cold storages with a view to making them commercially viable by encouraging sizeable research programmes

Of course, no energy transition can unfold overnight. There are also substantial problems in having a system which is economically viable over a long term But given the enormous energy appetite and explosion of interest in the solar age the world over, we had better catch up with this welcome trend. Solar air-conditioning may be a luxury for a poor country like India To ensure thermal comfort, judicious use of courtyards, verandahs, climate-adapted architectural sun-control, shrubs and fountains and evaporative cooling should be resorted to before any mechanical air-conditioning, solar or otherwise, is contemplated.

Solar refrigeration, on the other hand, has more direct and relevant application in villages and towns and isolated communities where cold storage facilities for storing medicines in primary health centres, for storing fish in coastal regions, for preserving vegetables, fruits, milk, eggs etc, besides agricultural produce, are inadequate and mostly non-existent. Solar-augmented cold storage units working on the aqua-ammonia vapour absorption refrigeration system must be encouraged and developed in right earnest It is hoped that research and development would be continued in this vital field to make such systems more competitive and commercially attractive The success already achieved reinforces this optimism and expectation

Mr Dixit who is on the mechanical engineering faculty of the Visvesvaraya Regional College of Engineering, Nagpur, is currently working on a doctoral research programme on the simulation of the vapour absorption refrigeration system at the mechanical engineering department, Indian Institute of Technology, Bombay Other areas of his research interest are solar ponds and heat transfer augmentation techniques

The Answers

(Continued from page 33)

1. Acrophobia:—b. Fear of heights Many acrophobics find it difficult to climb a ladder or a staircase In some persons being only a few feet from the ground causes considerable panic while others can climb a ladder to a reasonable height but are terrified when they approach the cliff edge

2. Belonophobia—a Fear of sharp objects Belonophobics have an abnormal fear of sharp instruments, including knife, scissors, razors or shears It has its origin in the Greek word *belone*, meaning a needle

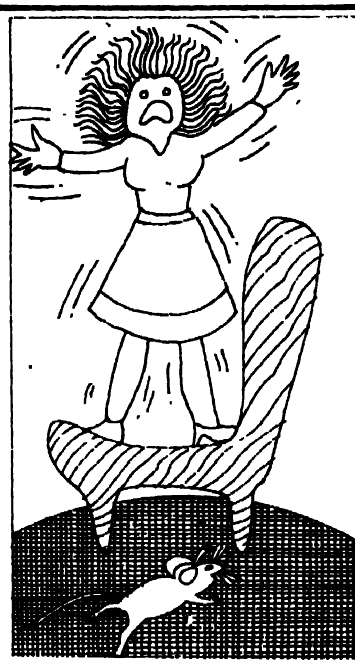
3. Agoraphobia—b Fear of open spaces The word is derived from the Greek word *agora*, meaning market place or a place of assembly And as early as 1873, this phobia has been recorded by Dr C Westphal in the *Journal of Mental Sciences*, XIX

4. Xenophobia -c Fear of strangers

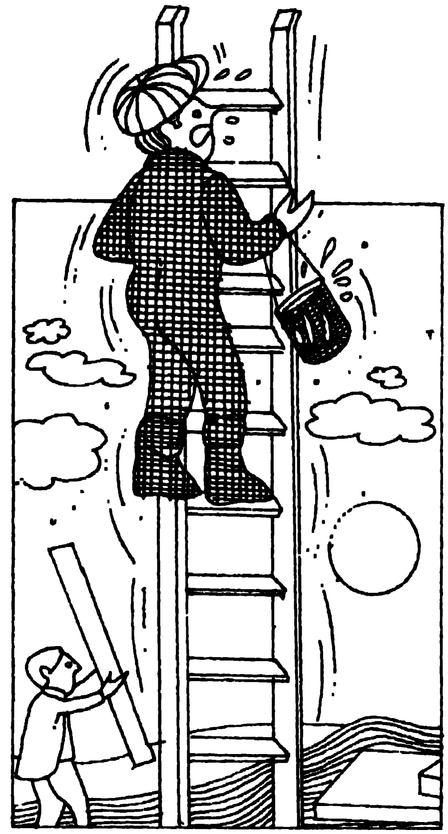
5. Herpetophobia—a· Fear of reptiles or lizards The word has its origin in the Greek word *herpetos*, meaning creeping or crawling things. This phobia can include all creeping creatures, including snakes, which otherwise alone induces fear in ophidiophobics those who fear snakes

6. Autophobia:—a Fear of being alone Also known as monophobia it is a fear of oneself or of being alone

7. Musophobia—b: Fear of mice Fear of animals is one of the common types of phobias. Severe musophobics become paralysed with fear at the sight of a mouse, often scream in terror and on occasions some actually faint It is believed that musophobia and fear of other animals may have a symbolic meaning



8. Arachnophobia—c· Fear of spiders The word arachnida suggests a class of the Arthropoda comprising spiders, scorpions and mites It is an irrational fear towards spiders Arachnophobics become anxious with a feeling of nausea when they see a spider



9. Nosophobia—a· Fear of illness or a disease Also known as pathophobia Some individuals develop extreme fear of specific illness or diseases, eg: cancer or syphilis, or become unusually concerned about their health Nosophobia, it is believed, may occur as part of a mental disorder, or an obsessional neurosis, or as a part of depressive illness

10. Ochlophobia—b Fear of crowds Ochlophobics shun crowds and crowded environments

Win a prize!

Due to unforeseen circumstances we are unable to announce the winners of the July quiz However, don't let that dishearten you We would like you to frighten us with as long a list of phobias as you can. The longest and the creepiest list wins a prize The last date is 1st December 1984

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Presiding over the first Geneva Conference (1955)

HOMI Bhabha's role in building up the science and technology (S & T) infrastructure and capability in post-Independence India is unquestioned. It would be of great interest to trace the development of his thinking in this vital domain through his writings, correspondence, notes and published papers since this would provide a wealth of information and insights, not only into the working of a great visionary mind, but also into the process of building up the base of organized science in our country at a critical phase of its history. Unfortunately, Bhabha's correspondence and other papers have not yet been published or worked upon. In the meantime, it may be worthwhile to see what emerges from the articles and speeches, and the extracts from a few of his letters that have appeared in print

"Growing Science"—from Bhabha's writings

B.M. Udgaonkar

Homi Bhabha went to Cambridge in 1927 as an undergraduate student, and spent the next twelve years of his life in Europe, except for brief visits to India during vacations. He was on a holiday in India in 1939, when the outbreak of the second World War prevented him from returning to Cambridge to continue with his research there This led him to accept a position at the Indian Institute of Science, Bangalore, as Reader in charge of a special Cosmic Ray Research Unit, which was set up for him with money provided by the Sir Dorab Tata Trust In 1942, he became a Professor He was elected to the Fellowship of the Royal Society of London in 1941, and received the award of Adam's prize in 1942

The five-year period (1940 45) that Bhabha spent at Bangalore was the crucial stage during which he re established an identity between himself and his country, and became aware of the role that he could play in the development of India, then on the threshold of Independence He discovered his mission in life, and was able to get the critical initial support from the Sir Dorab Tata Trust to take off on that mission.

During this period, Bhabha could not but contemplate on the status of scientific research in India He had noted that "there was no scientific institution in India devoted solely to fundamental research, especially in the newest branches of physics, namely nuclear physics and high energy physics" In a letter dated 19 August 1943, Bhabha wrote to J R D Tata "The lack of proper conditions and intelligent financial support hampers the development of science in India at the pace which the talent in the country would warrant" This letter very soon led to the creation of the Tata Institute of Fundamental Research (TIFR)

We do not know how precisely his thinking changed during this period For, in his formal letter dated 12 March, 1944 to Sir Sorab Saklatvala, Chairman of the Sir Dorab Tata Trust, proposing the setting up of TIFR, he wrote "I had the idea that after the war I would accept a job in a good university in Europe or America, because universities like Cambridge or Princeton provide an atmosphere which no place in India provides at the moment But in the last two years, I have come more and more to the view that *provided proper appreciation and financial support are forthcoming*, it is one's duty to stay in one's own country and build up schools comparable with those that other countries are fortunate in possessing " Years later (1962) he was to write, "For every thousand scientists who can do reasonably good work in a good scientific atmosphere, there is only one who can create the atmosphere for himself in a place where it does not exist, and this alone is a test of the outstanding scientist"

Role of S & T in development

In his famous address to the International Council of Scientific Unions on 7 January, 1966, a couple of weeks before his sudden death in an air-crash, Bhabha said· "What the developed countries have and the underdeveloped lack is modern science and an economy based on modern technology The problem of developing the underdeveloped countries is therefore the problem of establishing modern science in them and transforming their economy to one based on modern science and technology *An important question which we must consider is whether it is possible to transform the economy of a country to one based on modern technology developed elsewhere without at the same time establishing modern science in the country as a live and vital force* the problem of establishing science as a live and vital force in society is an inseparable part of the problem of transforming industrially underdeveloped to a developed country" (emphasis added).

Earlier, at the inauguration of the TIFR in 1945, he had remarked, "The pursuit of science and its applications are no longer subsidiary social activities today. Science

Alas, the situation has not changed very much over the last twenty years, in spite of the oft-repeated slogan of self-reliance!

forms the basis of our whole social structure without which life as we know it would be inconceivable As Marx said, 'Man's power of nature is at the root of history', and we have in our own times seen the history of the world shaped by those countries which have made the greatest scientific progress"; and then a remark which reminds us of a similar sentiment appearing later in the Science Policy Resolution of the Government of India (1958)· "Science has at last opened up the possibility of freedom for all from long hours of manual drudgery and today we stand at the beginning of an age when every person will have the opportunity to develop himself spiritually to his fullest stature "

Pure vs applied research

Developing countries have often been advised by the developed countries to concentrate on 'useful' or applied research, rather than indulge in 'the costly luxury of basic research' What was Bhabha's thinking at this time about the role of basic research?

Soon after the above-quoted letter to J R D Tata, Bhabha, in September 1943, read a paper at a Symposium of the National Institute of Sciences of India, in which he dealt with this question at some length He wrote: "It is customary to divide research work into two categories, pure research and applied or industrial research This division is a matter of convenience and may usefully continue to be made It is, however, most important to realize that this division does not carry with it the least implication of the relative usefulness, or practical benefit to mankind of the two categories of research This point cannot be overemphasized since the contrary view still prevails among many influential men in government and industry in India despite the fact that it has been long abandoned in progressive countries like Great Britain, the USA and the USSR" He takes the development of the electromagnetic theory and the invention of wireless as an illustration, and points out that "this example brings out clearly that pure and applied research are but two stages in the historical development from ignorance, through knowledge, to control, of the phenomena of nature in any given field There is, therefore, no question of differences in practical importance between the two categories of research One should rather look upon 'pure' research as long-term research while technical research, being historically the later stage in any line of development, may be looked on as short-term research"

He adds, " No country, which wishes *to play a leading part in the world can afford to neglect pure or long-term research*, for it is precisely on this research that depend the developments in industry and public economy which are likely to take place, say, twenty-five years hence. This fact should always be borne in mind when money is allocated for research" (emphasis added).

Interestingly enough, he takes the example of USSR in this context, and goes on to say: "This principle has been fully accepted by the extremely practical and efficient administrators who are responsible for the government of the Soviet Union today They do not draw a line between 'pure' and 'technical' research and they believe that *'there is no genuine knowledge of the universe that is not potentially useful for man, not merely in the sense that action may one day be taken on it, but also in the fact that every new knowledge necessarily affects the way in which we hold all the rest of our stock* The great success of the USSR in the economic, social and military fields are due to this enlightened policy, and India would do well to follow it " (emphasis added).

Inevitably, Bhabha comes back to this theme several times in the years to come For example, in his letter to Sir Sorab Saklatvala mentioned earlier, he writes "It is absolutely in the interest of India to have a vigorous school of research in fundamental physics, for such a school forms the spearhead of research not only in less advanced branches of physics but also in problems of immediate practical application in industry If most of the *applied* research done in India today is disappointing or of very inferior quality, it is entirely due to the absence of a sufficient number of outstanding *pure* research workers who would set the standard of good research and act on the directing boards in an advisory capacity ." He then takes the experience of the Department of Scientific and Industrial Research in the UK as an example

In proposing the creation of TIFR, Bhabha was thus thinking of 'a spearhead of research' Modesty did not prevent him from saying to Sir Sorab Saklatvala. "The scheme I am now submitting to you is but an embryo from which I hope to build up, in the course of time, a school of physics comparable with the best anywhere " At the same time, his approach to the development of such a school was not a cloistered or ivory tower approach He was thinking of much more than the mere creation of first-rate institute of fundamental research, important as it was. His vision went beyond that to the training of high quality manpower needed in different tasks of national development. Thus he added: " .. when nuclear energy has been successfully applied for power production in say a couple of decades from now, India will not have to look abroad for its experts but will find them ready at hand."

Later in 1962, Bhabha, as Director of TIFR, was to say proudly, "It is not an exaggeration to say that this Institute was the cradle of our atomic energy programme, and if the AEET (renamed Bhabha Atomic Research Centre after his death) has been able to develop so fast, it is due to the assisted take-off which was given to it by the Institute in the early stages of its development." He was also to remark more generally, "The support of such (fundamental) research, and of an institution where such research can be carried out effectively, is of great importance to society. *.paradoxically, it has an immediate use in that it helps to train and develop, in a manner in which no other mental discipline can, young men of the highest intellectual calibre in a society into people who can think about and analyse problems with a freshness of outlook and originality which is not generally found* Such men are of the greatest value to society... " (emphasis added)

Even at the International Conference on Cosmic Rays at Jaipur in 1963, in an after dinner talk, Bhabha remarked, "This (conference) will indeed stimulate the growth of cosmic rays and we hope that the effect of this growth of fundamental science will reflect itself more and more in the growth of applied science which we now need so desperately in this country for developing our industry. As industry grows, of course, applied science will also grow But we would like to give this a great push forward "

Allocation of scientific research to universities

"Long-range research would appear in general best carried out in the universities or in special institutes attached to the universities," remarked Bhabha in 1945, "*since while the research is in progress, its development and trend should be entirely unhampered by any thought of immediate utility* It is precisely in this way that knowledge of the domain of nature concerned can be most rapidly accumulat-

ed, leading to the subsequent practical applications in the shortest possible time. Moreover, the best universities *should* have, to a large extent, the staff necessary for the work, and vice versa, the staff necessary for pure research is in general suitable for teaching the wide subjects which are normally taught in universities " He was, however, conscious of the constraints of the university system as it had developed in India: "But such a programme", he continued, "would need a very widespread revision of our university system in India, where with a few exceptions, research facilities are very inadequate, and the staff overburdened with teaching duties" (emphasis added)

Even so, in his proposal to start the TIFR, Bhabha envisaged a close relationship with the University of Bombay In fact, when, on 14 April, 1945, the Trustees of the Sir Dorab Tata Trust accepted Bhabha's proposal to set up the TIFR, they minuted that the responsibility for the Institute should be shared from the outset with the Bombay University and the Bombay Government both in respect of finance and administration Dr Bhabha was present at this stage of the meeting and readily accepted the Trustees' views regarding the sharing of responsibility While the Government of Bombay joined the Trust in founding the Institute, the matter does not seem to have been followed up with the University of Bombay But Bhabha continued to be interested in a close relationship with the University At the foundation stone-laying ceremony for the new building of the Institute in 1954, he remarked "After much searching this site was located in this area because among other factors, it was near the University Contact with students is a revitalizing factor for the research worker, and conversely we feel that the presence of the Institute here will be of some advantage to the University "

Later he was to say, " Above all, scientific teaching and research at the universities must be strengthened and expanded. The universities are, however, autonomous organizations, jealous of outside interference, and the process must necessarily be slow and time consuming. It is probably for this reason that it has been considered expedient in many countries to set up national research laboratories and other scientific organisations for specific subjects "

It is interesting to note that in the 1943 paper quoted earlier, Bhabha advocated that "the pure or long-range research which should be allocated to the universities should have *the widest possible range* It should include on the one hand research in all branches of 'pure' mathematics...At the other extreme it should include problems of a practical nature but requiring long term planning of research, as for example the development of the technique for using nuclear energy for power production. . . ." He cautioned that given the cost of competitive research "it would clearly be best to concentrate the large research departments in a few big universities, for to spread them all over would merely result in inadequacy of financial means for all "

It is unfortunate that university research has failed to get the kind of imaginative and selective support on an adequate scale that was envisaged by Bhabha, and that the university system has not undergone the kind of basic structural changes that could have invigorated it In the meantime, more and more institutes, in science and social sciences, have got created outside the university system

Growing scientific institutions

"Ours is to be in many ways the job of pioneers building up science in a backward country," wrote Bhabha to S Chandrasekhar on 20 April 1945, within a week of the approval of his proposal to create TIFR by the Sir Dorab Tata Trust, "and though this may make it more difficult it also makes it more worthwhile and the achievement will be greater " How did he go about meeting this challenge?

In 1963, in his Presidential Address to the National Institute of Sciences of India (now INSA), Bhabha remarked " . we in India are apt to believe that good scientific institutions can be established by Government decree or order *A scientific institution, be it a laboratory or an academy, has to be grown with great care like a tree* It's growth in terms of quality and achievement can only be accelerated to a very limited extent. This is a field in which a large number of mediocre or second-rate workers cannot make up for a few outstanding ones, and a few outstanding ones always take at least 10 to 15 years to grow Too many of our National Laboratories have been estabished by deciding upon the field in which it was desired to work and by drawing up an organisational chart on the pattern of some corresponding large laboratory abroad"

"No organizational chart of the future development of the Institute was submitted either when it was founded or later, and the philosophy has always been to support ability wherever it is found in the fields of work covered by the Institute. Indeed, the philosophy underlying the founding of the Institute was the same as that underlying the Max Planck Institute in Germany, namely 'The Kaiser Wilhelm Society shall not first build an institute for research and then seek out the suitable man, but shall first pick up an outstanding man, and then build an institute for him "

In fact the 'Scheme for an Institute for Advanced Theoretical and Experimental Research in Physics' that Bhabha submitted to the Sir Dorab Tata Trust in March 1944, envisaged a total annual expenditure of Rs 45,000 only for core staff, did not ask for a new building, and proposed that "the Institute be expanded not by the usual procedure of creating posts and then trying to find suitable men to fill them, but by waiting till men of exceptional ability and promise show themselves, and creating suitable posts for them "

Self-reliant development

Describing the growth of the atomic energy programme, in the ICSU address, Bhabha remarked, "The emphasis has been throughout on developing knowhow indigenously and on growing people able to tackle the tasks which lie ahead The generation of self-confidence and the ability to engineer and execute industrial projects without foreign technical assistance have been major objectives" He mentioned the collaborations with UK and Canada, but emphasized "the relative roles of indigenous science and technology and foreign collaboration through an analogy Indigenous science and technology plays the part of an engine in an aircraft, while foreign collaboration can play the part of a booster A booster in the form of foreign collaboration can give a plane an assisted take-off, but it will be incapable of independent flight unless it is powered by engines of its own If Indian industry is to take-off and be capable of independent flight, it must be powered by science and technology based in the country."

Dr Ramanna has remarked, "I recall Homi Bhabha telling me that the introduction of atomic energy in India in the early 1950s was not purely for the sake of introducing atomic power, but essentially for the introduction of new technologies dependent on basic sciences generated from within "

In the ICSU Address (1966), Bhabha bemoaned the fact that "Indian industrial development has so far proceeded almost exclusively on the basis of setting up plants and industries with foreign collaboration.

"Science has at last opened up the possibility of freedom for all from long hours of manual drudgery and today we stand at the beginning of an age when every person will have the opportunity to develop himself spiritually to his fullest stature..."

Our own experience makes it quite plain, however, that this method can never lead to a self-generating industry without at the same time establishing a powerful scientific research and development effort to support it". On the other hand, he reminds us: "The steel industry has existed in India since the First World War, and one of the two steel plants was among the largest in the British Commonwealth in the early twenties Yet when the steel plants had to be expanded, it was necessary to draw upon foreign consultants and engineering firms to plan and carry out the expansion" Thus came the German consortium for Rourkela, Russian technical collaboration for Bhilai, a British consortium for Durgapur, and essentially the same method for Bokaro "Thus the construction and operation of a number of steel plants has not automatically generated the ability to design and build new steel plants", he summarized, and warned "Unless powerful scientific and engineering groups are established during the construction and operation of existing steel plants as a matter of deliberate policy, the dependence on foreign technical assistance will continue and the steel industry will not reach a stage of technical self-reliance. A similar situation exists in almost every other industry" *Alas, the situation has not changed very much over the last twenty years, in spite of the oft-repeated slogan of self-reliance!*

Speaking in 1966, Bhabha could not but refer to the fact that "the recent stoppage of foreign aid had shown our tremendous foreign dependence on a vast variety of materials and equipment, many of which could and should have been produced in the country long before this"

In the same Address, he also pointed out that "Many examples can be given of foreign collaboration resulting in badly engineered plants or technical mistakes, and when such technical mistakes are corrected the foreign consultant benefits from the experience Whereas, if an Indian scientific or engineering organisation had been employed, the experience gained even from initial failures could have been a gain to the country The Soviet Union did not hesitate to follow this path"

Another pertinent point that he made, which does not seem to be sufficiently realized in the country even now, was that "in buying foreign know-how one is paying for an element which covers the cost of research and development done by the foreign consultant, and it is clear that a more permanent benefit would result to

At the inauguration of the Cirus reactor (1961) at the BARC, Bombay

the country if this money were made available for supporting research and development in India"

As Bhabha remarked in his INSA Presidential Address on 6 October, 1963, "Indian science and technology will only come of age when we have learnt to design and build steel mills, engineering works, chemical plants, power equipment, etc *ourselves, without having to depend on foreign consultancy* There is an almost universal tendency today, whether in the private or the public sector to think immediately of finding a foreign consultant whenever some new plant or industry has to be established. In many cases, I think, this is due entirely to *a habit of mind and to a lack of national self-confidence*"

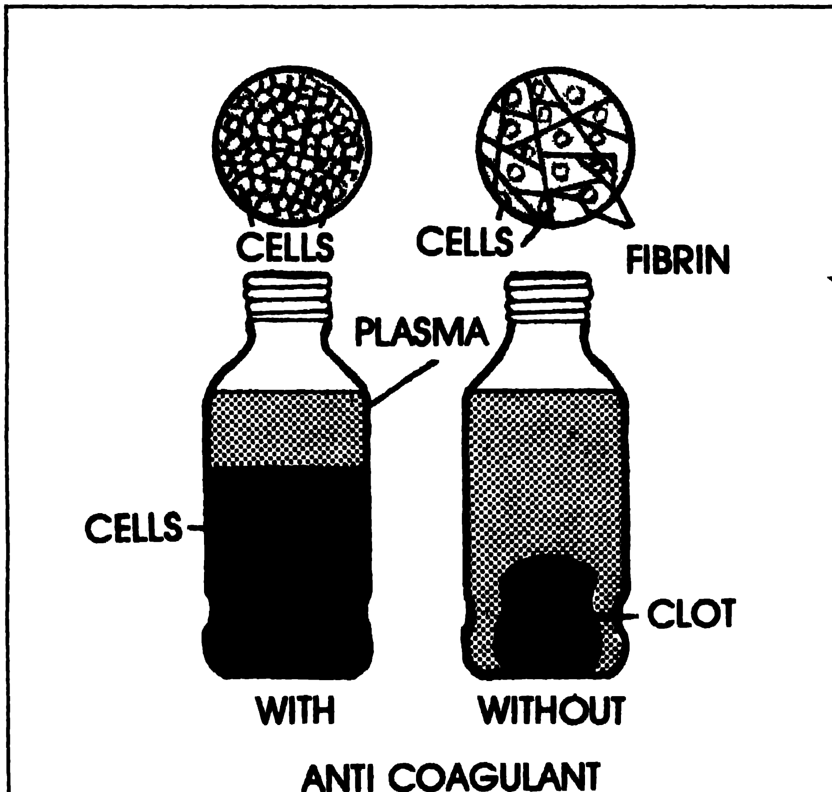
(to be concluded next month)

Prof Udgaonkar is with the Theoretical Physics Group, Tata Institute of Fundamental Research, Bombay and is editor, Physics News He was earlier Scientific Advisor to the Planning Commission

HOW **BLOOD** CLOTS

IT is our common experience that bleeding through a tiny cut stops automatically in two to three minutes. Secondly when blood is collected from veins and placed in a test tube it clots within 10 minutes. How does this happen? Studying patients with an inborn or acquired deficiency of clotting factors have given us an insight into this mechanism The modern biochemical methods allow us to describe the process of coagulation in the form of a chain of reactions involving several elements known as clotting factors. The Roman numerals I to XIII (see table below) assigned to the clotting factors relate to the order of their discovery rather than to their position in the chain of reactions. Thus, traces of the history of blood coagulation research remain in this international nomenclature

In the primary arrest of bleeding the platelets and fibrin together form a plug Platelets fall out of the blood stream and adhere to the vessel wall at the site of injury. They then get degranulated and liberate adenine nucleotides which mediate further platelet aggregation with the help of ionized calcium and fibrinogen Finally fibrin deposits around platelet aggregates to form a seal over the breach in the vessel Patients with haemophilia may exhibit a normal bleeding time indicating that they can form platelet-fibrin plug, and yet suffer from spontaneous haemorrhages into muscles and joints, because of factor VIII (AHF) deficiency



CLOTTING OF BLOOD

When blood is placed in a test tube it clots within 10 minutes and in the next 30 minutes the clot retracts releasing the serum. Microscopic examination of the clot shows it to be composed of irregularly arranged fibrils, in the intersnces of which are trapped cells The cells do not take part in the clot formation Plasma can be made to clot At least 10 proteins present in the plasma are involved in the coagulation mechanism The insoluble fibrin forms the network to trap the cells Fibrinogen produced in the liver is the precursor of fibrin and of all the proteins participating in clot formation, the concentration of fibrinogen is the highest (150-400 mg%) The conversion of fibrinogen to stable fibrin by thrombin and calcium ions is the end of the chain of reactions The special feature of this chain is that the substrate for each enzyme is a proenzyme which becomes the active enzyme for the next reaction The active enzyme is designated by the suffix 'a'. The chain thus functions as an enzyme amplifier, so that a small change at the beginning may result in the formation of large amounts of thrombin and fibrin at the end Calcium ions are required at several stages in this chain Prothrombin, a stable protein present in plasma, is a precursor of thrombin Thrombin mediates removal of fibrinopeptides to form a fibrin monomer which polymerizes to form a visible clot

CLOTTING FACTORS

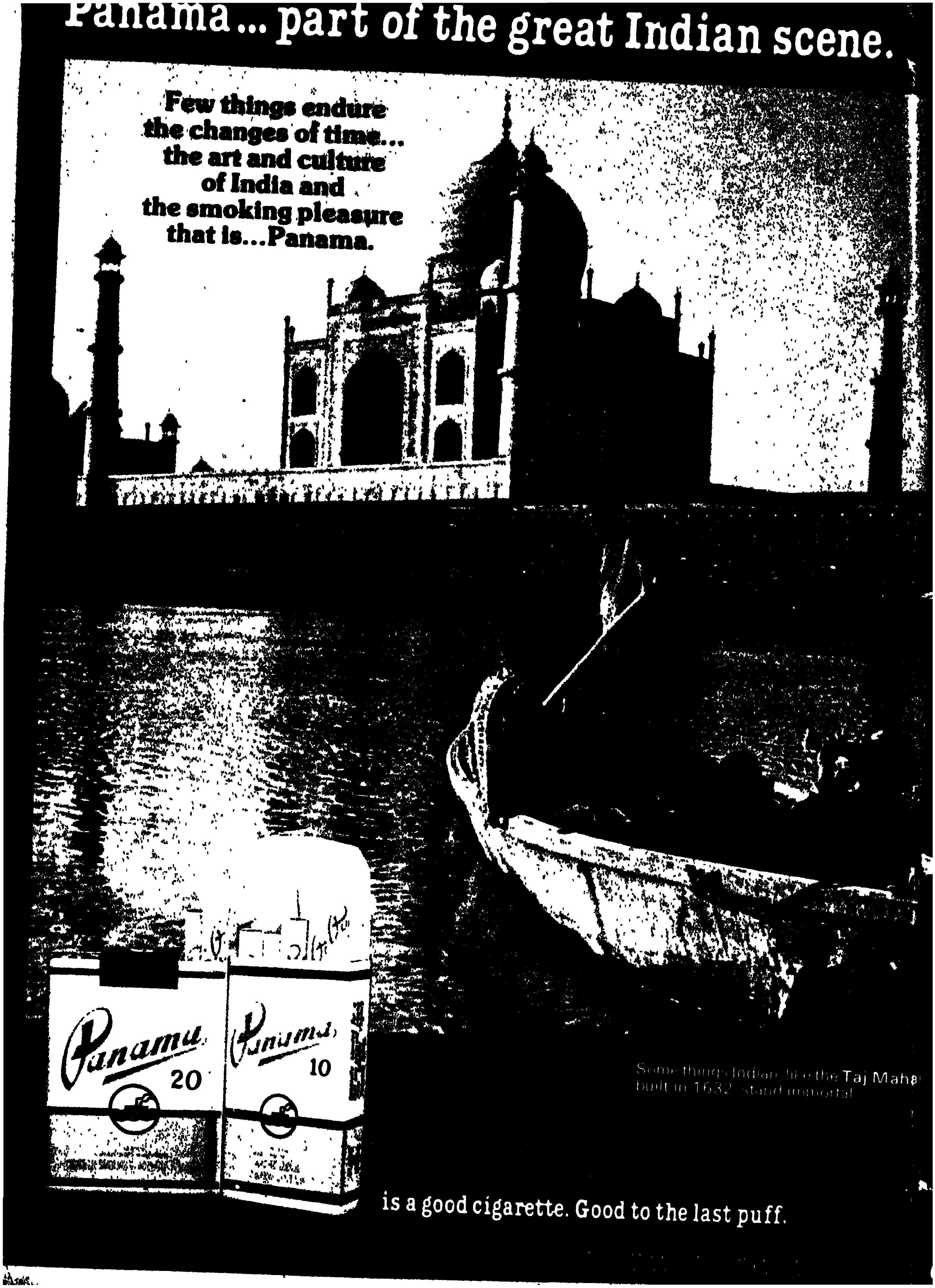
Factor	Synonym
I	Fibrinogen
II	Prothrombin
V	Proaccelerin (liable)
VII	Proconvertin (stable)
VIII	Antihaemophilic factor (AHF)
IX	Christman factor, plasma thromboplastin component (PTC)
X	Stuart-Prower factor
XI	Plasma thromboplastin antecedent (PTA)
XII	Hageman factor
XIII	Fibrin stabilizing factor

Factors III, IV and VI are no longer in use

The clotting system has two inputs called intrinsic and extrinsic mechanisms Clotting without the assistance of thromboplastin is referred to as intrinsic In this, surface contact plays an important role If blood is placed in a nonwettable tube (plastic, siliconized) the clotting is delayed, and if glass beads are kept in the tube, clotting is accelerated In the extrinsic mechanism, clotting is much more accelerated by adding tissue extract (thromboplastin) Tissue extracts react with factor VII and calcium ions to produce a product which activates factor X and so by-passes the early phases of blood coagulation. Clotting is completed in 10-20 seconds Various snake venoms (Russell's viper, Malayan pit viper) produce accelerated blood clotting via the extrinsic pathway

V.D. Joglekar

Mr Joglekar was Deputy Director, Forensic Science Laboratory, Bombay He was also consulting biochemist with Bombay Hospital


Panama... part of the great Indian scene.
Few things endure
the changes of time...
the art and culture
of India and
the smoking pleasure
that is...Panama.
Panama
20
Panama
10
Some things Indian like the Taj Mahal
built in 1632 stand immortal
is a good cigarette. Good to the last puff.

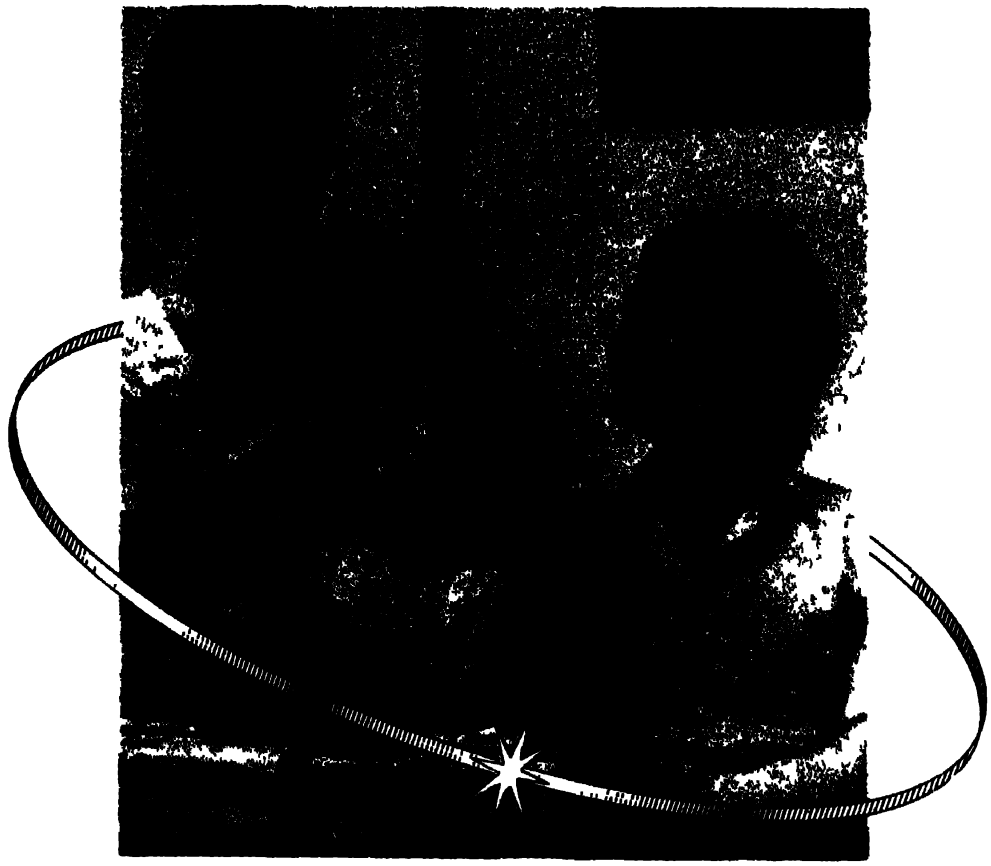
November 1984 Rs. 4

SCIENCE TODAY

PRESERVATION OF PAINTINGS

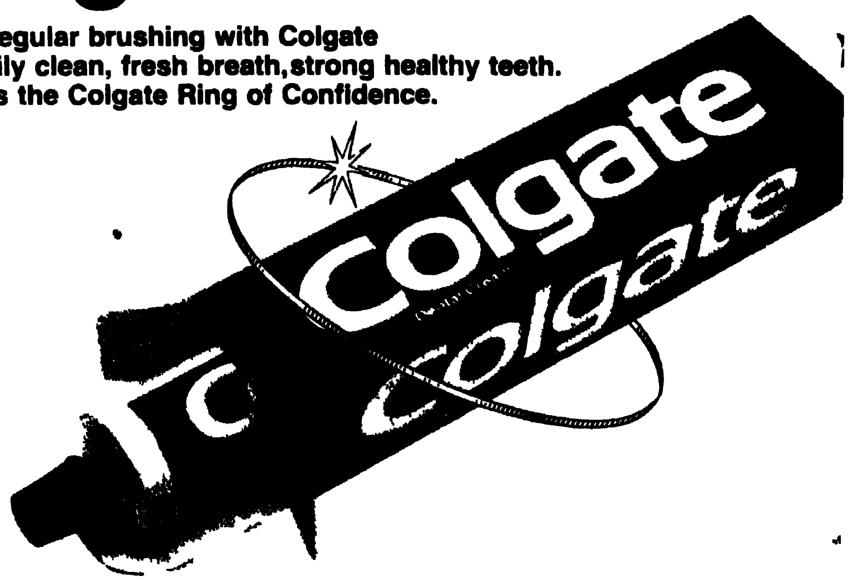
IS INTELLIGENCE INHERITED?

Stop bad breath. Fight tooth decay.



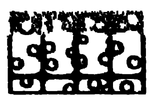
Give them the Colgate Ring of Confidence!

Regular brushing with Colgate
gives your family clean, fresh breath,strong healthy teeth.
That's the Colgate Ring of Confidence.



This is how Colgate s trusted formula works for you every time you brush

Bacteria grow in food particles trapped between teeth causing bad breath and tooth decay



Colgate s unique active foam reaches deep to remove odour-causing food particles and decay-causing bacteria

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Make sure your family brushes with Colgate after every meal
Stop bad breath, fight tooth decay
Give them the Colgate Ring of Confidence

You'll love its fresh minty taste

SCIENCE TODAY

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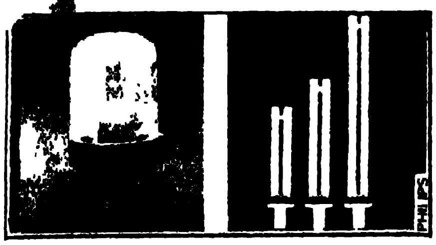
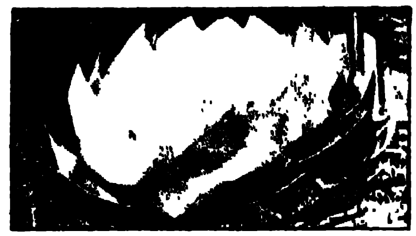
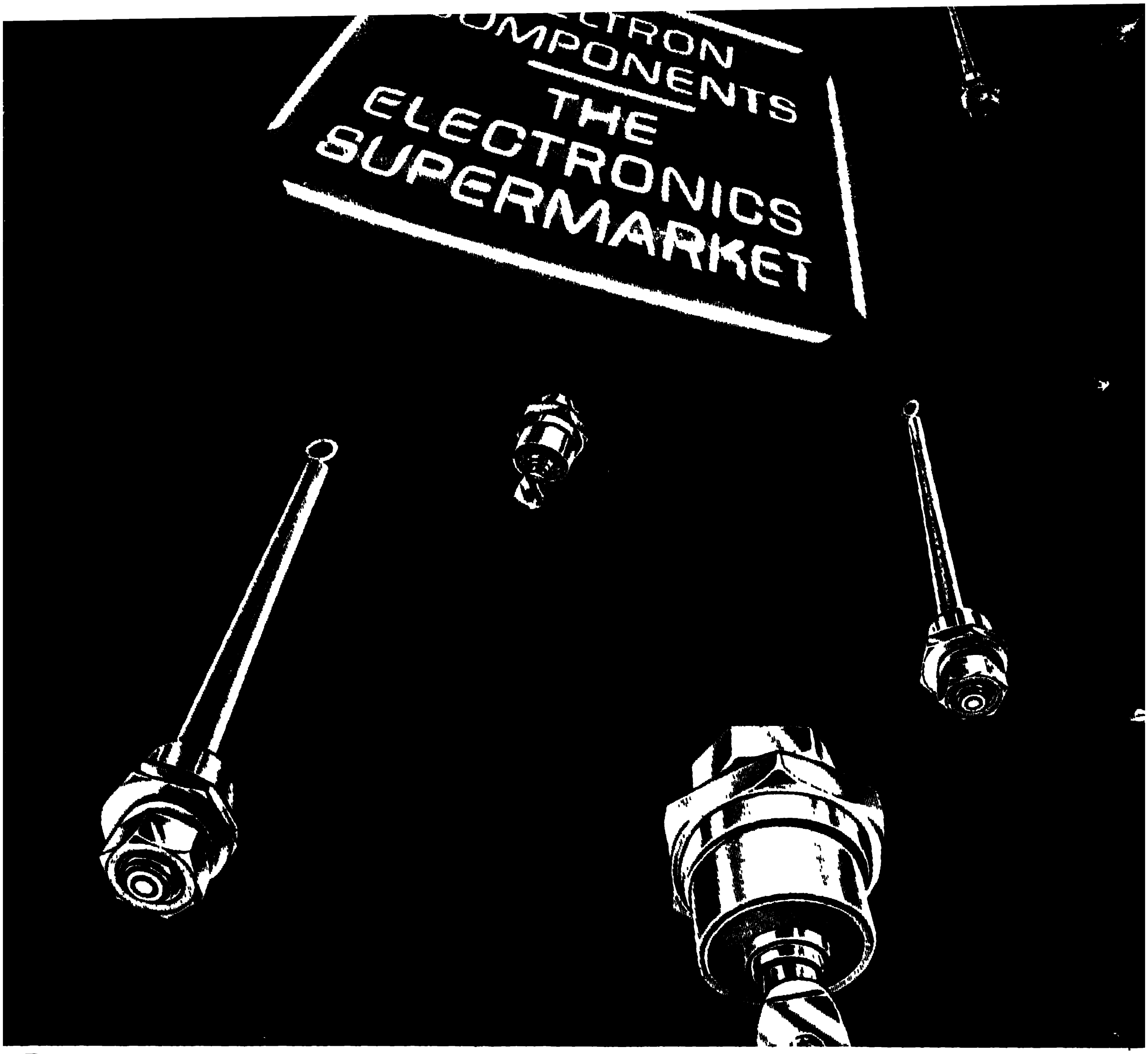
November 1984





COVER DESIGN BY RAMESH SANZGIRI



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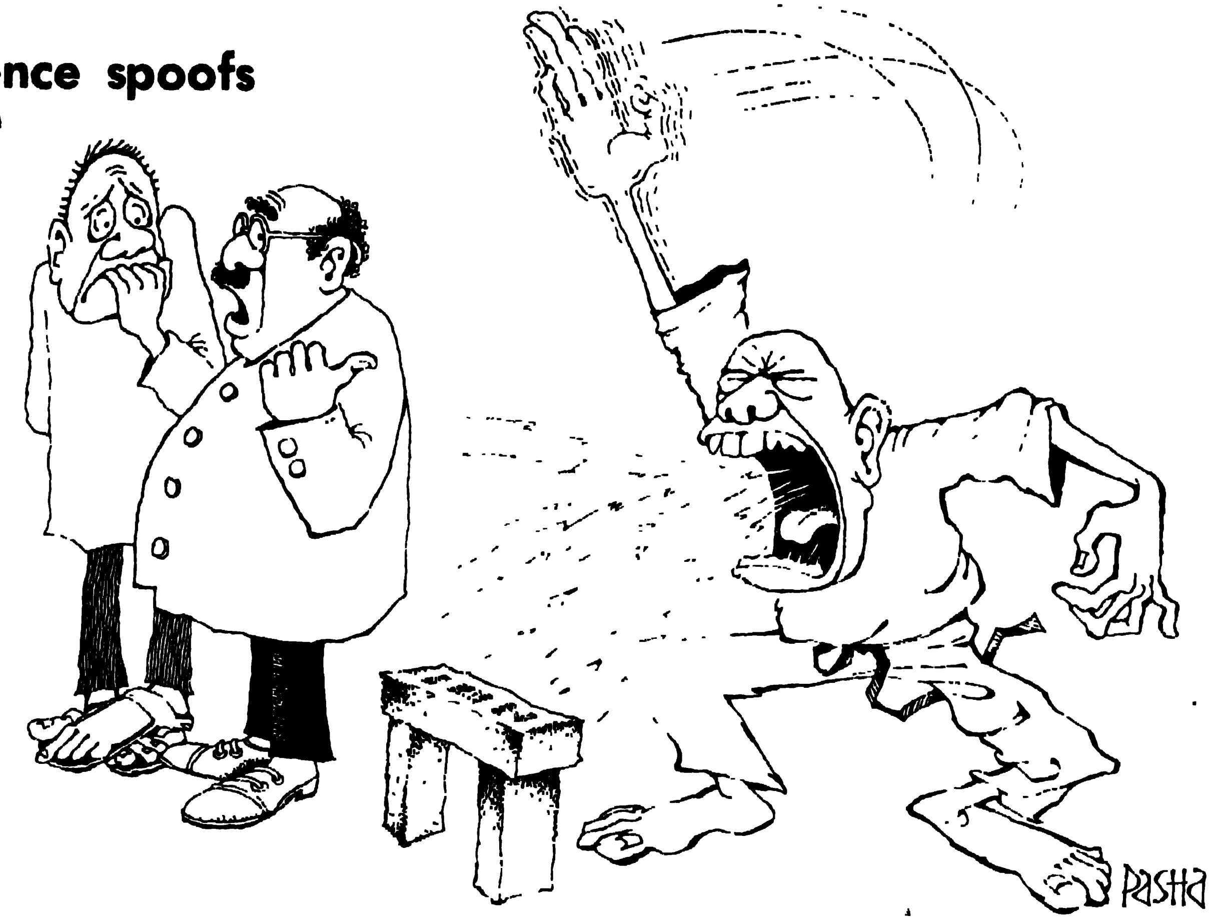
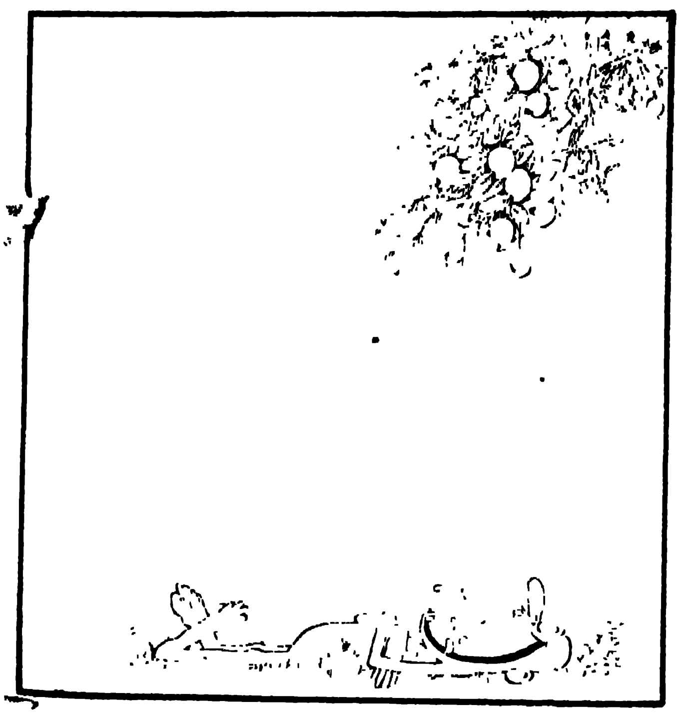
Science spoofs
Pasha



It's a new wave sonic karate!



Thank Newton for his delicious Law of Gravitation...

...Oh, damn! I take back my words...

SCIENCE and technology are often accused of creating Frankensteins while trying to sire angels. Especially in a tradition-bound conservative society like ours which does not readily, or kindly, embrace modern concepts, this charge usually acquires ominous tones of doom. Any tinkering with Nature, it is argued, is not likely to be looked upon with a tolerant or benevolent eye It is, therefore, believed that Nature is bound to retaliate This skeptical, but not necessarily anti-science lobby, is sure to see in the recent report on the use of antibiotics in cattle on British farms a further proof of their worst fears

According to papers published in *Science* and *The New England Journal of Medicine*, antibiotics given to animals to make them grow faster are an important cause of a growing number of human infections Some of them are fatal because these antibiotics encourage the spread of *Salmonella* strains that are resistant to life saving drugs. We would not be surprised, if the news on antibiotics goads some apparent do-gooders to press for a ban on antibiotics totally

It is true that scientists, at times, get carried away by their own discoveries and advocate their immediate application in all spheres. But if we take an objective view, such ill-effects accruing from the misuse of a scientific development are far outweighed by their benefits to humanity

If we take an objective view, the ill-effects accruing from the misuse of a scientific development are far outweighed by their benefits to humanity

And even these relatively few setbacks cannot be directly attributed to science *per se* They are sired by practitioners who do not have time or inclination to study all aspects of the instrument that science has delivered to them

The fault lies, we feel, in the distorted and exaggerated accounts of scientific developments by ignorant practitioners, howsoever well-intentioned. The general masses get easily influenced by the sensationalised, eye-catching announcements in the lay press. Even policy-makers and other professional administrators would have to share the blame for the misbegotten progenies of science. They too do not get themselves fully acquainted with the advantages—and limitations—of even those scientific advances they are trying to further Nor do they make any efforts to educate those who are to be entrusted with the job of actual application of the fruits of science and technology In today's age of information explosion they have no excuse Unless they change their attitudes, the general populace will experience only the harmful effects of science and not its benefits

EDITOR

SCIENCE TODAY

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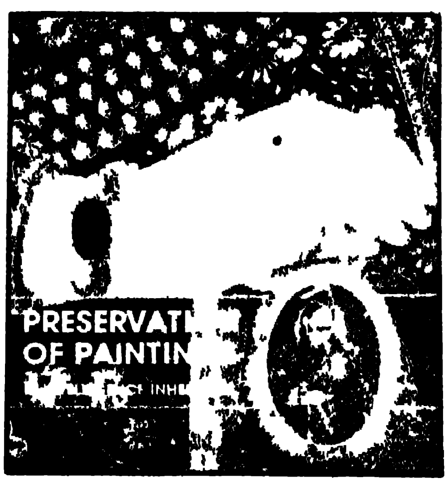
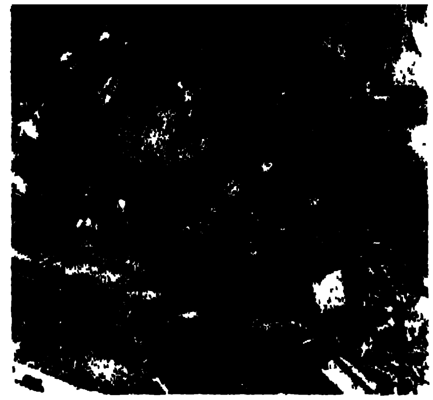


CONCRETE CONTROVERSY



Congratulations to Vithal C Nadkarni for the timely and soul-searching article "Concrete worse than clay" (June, 1984) The subject had not been dealt with previously by your magazine

Politicians, engineers and contractors are all responsible for the state of affairs in construction industry, involving concrete in particular Unfortunately, ISI Codes has specifications for the materials and methods involved in construction, but not for the men who manage it It is a tragedy that civil engineering profession is controlled by illiterate or not too technical contractors, and unwilling engineers As long as engineers, though qualified and technically competent, turn out to be mere 'puppets' in the hands of contractors and other powers that be, the profession and the population will continue to suffer

LAKSHMINARASIMHA RAO

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Vithal C Nadkarni is unduly harsh in his criticism of the construction industry in India If because of *Akashdeep* and *Gangaram* shopping complex collapses buildings are "the death traps", the railways can be branded as mobile "gallows" and the administration in the states of Assam and Punjab can be vilified as "butcher bureaucrats", considering the hundreds and thousands of deaths involved in rail accidents and the carnage of Assam and Punjab respectively As against one crumbling *Akashdeep*, there are numerous *"Akashachumbis"* standing solid in Bombay and other cities. The critics should not be totally blind to the facts, while advocating their theory of uselessness or waste of money invested in construction projects

By saying this, I do not intend to commend the happenings in the construction industry If the country incurs about 50% of its planned expenditure on construction industry alone, the men at the helm of affairs must take legislative measures to establish a central authority to grant licences to the practitioners of the concerned engineering profession and to the contractors with minimum qualifications and financial back up in the latter case, on the lines of the medical, law, accountancy, etc professionals Such legislations should then soon come into force

As a construction engineer of about 25 years' standing, on the practical side also I wish to highlight a few constraints of the field engineers/contractors in obtaining quality products for construction Unlike in other industries, products in construction industry, mainly concrete, now under discussion, is made up of basic ingredients obtained from nature without any process (except cement) Therefore, it is bound to vary in its qualities, though specifications are set forth by the National and International bodies Hence in spite of the best efforts on the part of engineers etc to maintain uniform qualities of these ingredients, it is impossible to adhere to the rules because of various site conditions and technical reasons

This is further aggravated by the lack of automation in quality control in this industry, compared to many other technologically advanced industries like steel, chemical, petroleum, etc This factor also entails insufficient curing of concrete which is the most harmful and neglected aspects in concrete making A controlled concrete mix can fail to give the requisite strength if badly cured, but an uncontrolled mix can give satisfactory results if methodically cured, as specified in all respects The availability of a particular category of cement, ordinary Portland or Pozzolana, needing different lengths of time for curing to gain the minimum strength also poses complications Considering these and several other factors, will it be justifiable to blame the engineer for the failure of the structure?

C I SHASTRY

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Beryllium—A gem of a metal

The article Beryllium The gem of a metal (April, 1984) by Dr H S Ahuja is interesting with data judiciously compiled and presented However, certain important aspects such as geology mineralogy, resources and industrial applications of beryllium should have been dealt a little more in detail and correctly to enhance the generalised nature of the article

India is endowed with vast resources of beryllium minerals, particularly the mineral beryl for use in both the engineering and gem industries The host rocks pegmatites, granites and metamorfics which occupy several thousand square kilometres of the Indian terrain are most productive in the states of Rajasthan, Bihar, Andhra, Madhya Pradesh, Orissa and Kerala Indian beryl generally contains BeO of the order 8% to 13% whereas exploitation of a deposit is usually considered economic if the content of the pickable beryl exceeds 0 02% Rajasthan has the distinction of producing large hexagonal beryl crystals sometimes weighing as much as 20 tonnes

Further coming to the beryllium minerals there are 45 recorded minerals (and not only 30 as reported), out of which six are the principal ores of beryllium—Beryl ($Be_3 Al_2$) ($Si_6 O_{18}$), Phenacite Be_2 (SiO_4), Chrysoberyl ($Al_2 BeO_4$), Bertrandite Be_4 (Si_2O_7)(OH) $_2$Helvite $Mn_8(BeSiO_4S_2)$ and Berylite ($Be_2 Si_2 O_7$) Perhaps due to an oversight or a printer's error, in para 5, lines 3 and 6, the word beryllium (2 BeO Al O 6SiO) has been used instead of Beryl ($Be_3Al_2(Si_6O_{18})$)

G S BHATANAGAR

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Rise of the robots

My hearty congratulations for publishing the valuable and informative article 'Rise of the Robot' by S A Khan (July, 1984) Goliath's Killer in the same issue is also interesting

NANDAM C. SHEKAR

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Putting population in the sea

A MARINE city on a man-made offshore island? The idea may sound far-fetched but not to the Japanese who have already 11 such islands. Now the Agency of Natural Resources and Energy, Japan, has called for vigorous promotion of industry-government cooperation to develop the advanced technologies necessary for a marine city.

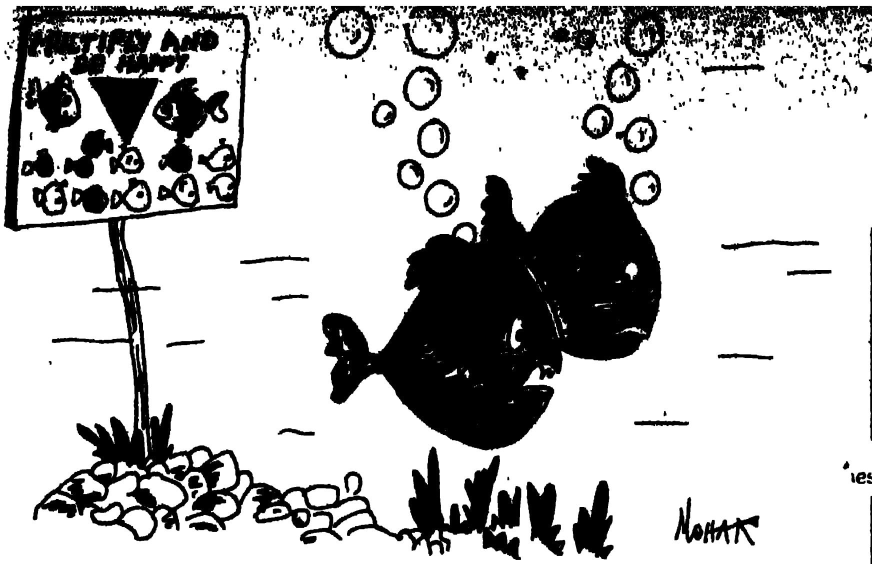
Japan ranked second only to New Zealand when its sea economic area increased to 4.5 million square kilometres when the 1982 Law of the Sea Conference gave recognition to the establishment of 200-mile economic zones. From then on research in the field of ocean resources—fisheries, including artificial fish pastures and the piping of light to the sea bottom to increase algal growth, seabed oil and minerals, wave power, extraction of uranium from sea water—has increased manifold.

The possibility of using sea as a place to store things is also being explored. Huge synthetic-skinned "sausages" full of oil may soon float in the oceans. And when the present cities are getting more and more densely populated putting some of the population also in the sea seems to be the most natural thing to do.

Can human gene disorders be put right?

ONE of the human gene disorders that has been extensively studied in recent years is thalassaemia. The disorder, in which there is a defective synthesis of the polypeptide chains of haemoglobin, results from a series of diverse structural mutations of the globin genes. Scientists now believe that if these defective genes are replaced, thalassaemia can be put right.

But before inserting globin genes into blood cells certain difficulties have to be overcome. The red cell precursors in the bone marrow are programmed to become mature cells and live for about 120 days in circulation. Therefore, the gene insertion has to be done into the target haematopoietic stem cells from which the red and white blood cells are



"Double standards, I'll say. I've heard they even subsidise their condoms."

derived, although there is no guarantee that the inserted genes would be expressed only in red cells or platelets. Also, techniques for inserting foreign DNA into cells are still not standardised.

David A. Williams and his colleagues in the US have been successful in introducing a marker gene into murine (pouched mammals) haematopoietic cells using a retrovirus vector (*Nature*, **310**, 476). They constructed a defective retrovirus vector containing a neomycin (antibiotics produced by a strain of bacteria) resistance gene and transferred it to the irradiated mouse haematopoietic cells. These transformed genes had the capacity of self renewal.

The authors point out a few difficulties before this technique can be used for gene therapy. Up to 15 picograms of globin may be required per cell to correct a thalassaemia defect, and hence the inserted gene would have to be very efficiently expressed in the host cells. Perhaps the therapy can be used in certain enzyme deficiencies.

The ill-fated adventures of the *Mutsu*

THE Japanese Government has decided to keep the nuclear ship *Mutsu* afloat despite all evidence that the project will serve no useful purpose. The decision, regarded as the bureaucratic equivalent of a "perpetual motion machine", is based on the notion that "we must spend more or the money we have spent may come to nothing."

The 8,200-tonne nuclear ship was ill-started from the moment of its launch in 1968. Although it was ready for sea-trials by 1972, the planners discovered their most crucial lapse—neglecting public sentiment—when the local fishermen launched a massive public blockade that was to last for two continuous years! The fishermen were terrified that *Mutsu*'s radioactive discharge would ruin their mainstay of living—scallop fisheries. It was a typhoon that broke the blockade and the *Mutsu* was finally able to slip out to the sea—at midnight. When the *Mutsu*'s reactor went critical a few days later, the planners' worst fears began to be realised. The reactor began to leak. And the ship was not allowed to port for repairs. The saga of improvised repairs on the high seas that followed would be worthy of any sea dog that values his salt!

Rice boiled in borates was used by the chef as radiation shielding. When that proved only partially successful, cast-off socks were added to the gruel! By now it was essential to get the ship back to port. While negotiations with the fishermen dragged on for over a month and a half, the *Mutsu* clearing a radioactive trail wandered about aimlessly. The fishermen extracted the final victory: *Mutsu* would be allowed to port only if it left within six months—permanently! Not only that, all the shore based facilities would be removed and a programme of public works would be launched by the government *along* with compensation for fall in sales of local shellfish tainted by the bad name given to the area by the *Mutsu!*

Wherever it went, from the *Mutsu* city in North Japan to Sasebo in Nagasaki or Ominato in Aomoei back in North, the ship was greeted by protesting flotillas and it had to keep moving. By 1984, the ship had incurred expenses of 57,000 million yen (Rs 17.5 crores) which is ten times the original

cost estimate on repairs, repairs and yet more repairs, plus some to pacify protestors!

Thus when it became clear that a further sum of 100,000 million yens would be required to bring the *Mutsu* to full operation, the Science and Technology Committee of the ruling Liberal Democratic Party recommended that the *Mutsu* be scrapped. Meanwhile the government decided that the ship could only be housed in a specially constructed port built at a cost of 60,000 million yens! Work began on this project a few months ago at Sekinghama close to Mutsu city.

In the meanwhile, the pendulum swung again. And it was decided to scrap the ship! But that was not the end. Once again, the *Mutsu* was revived with minimal support. Why was this volte face made? It seems that the Japanese mission that went to the US and Europe to gain co-operation on nuclear ship development received a negative reaction! Understandably, since nuclear powered ship are primarily used for military purpose and no one was willing to divulge the secrets won at enormous costs. Thus the supporters of the "Save *Mutsu*" campaign feel that outdated or not, *Mutsu* is the sole means of learning the tricks of the US nuclear-powered shipping trade.

The *Mutsu* experience has led the Japanese to do a bit of soul-searching. They are now thinking to form a new scientific review body apparently modelled on the US Office of Technology Assessment to avoid further such throwing away of money on projects without any clear goal in sight. The body would take overall control of, and coordination between, the different ministries and agencies concerned with science and technology.

Cancer-causing quality questioned

A CONTROVERSY has arisen in the US regarding the safety of cyclamates, the artificial sweeteners. While Gere Goyan, former Commissioner of the Food and Drug Administration (FDA) had refused to allow cyclamates back on the market in 1980, implicating them to be carcinogenic, a new study by the Cancer Assessment Committee of the FDA finds them safe for consumption. This turn of events has led the National Research Council to reassess the whole issue.

The ban on cyclamates came in 1969 when they were said to cause bladder cancer. From then on the manufacturers had been continually requesting the FDA to lift the ban. But Goyan did not budge saying that consumption of cyclamates increased all types of tumours in experimental animals.

However, the new study complains that Goyan had lumped together tumours at different sites so as to yield the appearance of statistical significance. Also data from different laboratories were used to control experimental data without allowing for differences between the spontaneous occurrence of tumours and differences in pathological procedures at the laboratories concerned.

The controversy also brings into picture another much-used artifical sweetener, saccharin. According to many FDA scientists, if at all cyclamates are carcinogenic they are much less so than saccharin, which they feel should eventually be banned. Meanwhile, the new artificial sweetener, aspertame, though said to be safe, cannot be used in products meant to be stored for long duration.

"No thanks! We know about those classified carcinogenic additives."

Banana-cure for ulcers

FROM curds to milk and wheat-grass therapy, now it is bananas for ulcer-cure. The recent issue of *The British Journal of Pharmacology* reports that certain chemicals in bananas prevent stomach ulcers in rats, even symptoms of ulcers already formed are alleviated.

The above findings were carried out by two collaborative research groups, one at Aston University in Birmingham, UK, and another at the Banaras Hindu University, UP. Prof. A.K. Sanyal of the BHU supplied the samples of banana powder, and the group at Aston extracted the active anti-ulcer compound from these samples. The final end-product was 300 times more active than the original banana powder.

Let us try to understand the mode of action of the banana extract on ulcers. The lumen of the stomach is lined by the cells of the gastric mucosa which secrete the mucus of the stomach cavity. The gastric mucosa layer is found througout the intestinal tract. Ulcers are formed when this mucus-forming layer is eroded by gastric juices acting directly on this layer. This can be brought about by drugs or certain diseases.

The Aston group observed that the growth of mucosa cells is stimulated when they are exposed to the purified active banana extracts. The new cells produce more mucus, which protects the mucosa membrane from the action of the gastric juice. Also, where the ulcers have already formed, the mucus flows into the ulcer craters and seals them from further attack of the gastric juice.

The banana powder (four grams per day) was tried on human volunteers. But all bananas did not have the anti-ulcerogenic property, ripe or cooked bananas did not possess the property. Unripe bananas picked five weeks before ripening had the active ingredients. Attempts are now being made to identify the active compound. Some twenty years ago the suggestion was that it is 5-HT which is contained in banana pulp. However, not only did the Aston group find 5 HT to be less effective than banana extract, but say that it is removed during solvent extraction.

Forgotten Man of Science: Professor Agharkar

THE 100th birth anniversary of the late Prof S P Agharkar, Founder Director of Maharashtra Association for the Cultivation of Science Research Institute (MACS) Pune falls on 18 November 1984 Prof Agharkar was born in Malvan in Konkan and matriculated from the Government High School, Dharwar, in 1901 He joined the Elphinstone College, Bombay, in 1902 and took the B A degree in first class with botany and zoology He won the Bell Prize for English in that examination He got the M A in 1909 with zoology botany and geology He was appointed immediately as lecturer and Head of the Biology Department in the Elphinstone College, Bombay He served until 1913

In 1913, he was invited to attend the centenary celebrations of Indian Museum, Calcutta, and this occasion proved to be the turning point in his life Calcutta University at that time was growing vigorously under the great educationist and humanist, Sir Asutosh Mukerjee At the suggestion of Dr C V Raman, who was later to win the Nobel Prize, then holding the "Prof Palit Chair" in physics Sir Asutosh asked Agharkar to apply for "Prof Ghose Chair" in botany and enquired whether he was willing to proceed to Germany for higher studies Agharkar agreed and went to Germany in 1914

Soon after his arrival in Germany World War I broke out and he was interned as an enemy subject in various camps till June 1917 He could take the proposed research only after he was released In December 1919 he was awarded Ph D degree by Berlin University where he worked under the renowned botanist Dr Adolph Engler On return to India he started his work as Ghose Professor of botany at Calcutta University from July 1920

An important matter pertaining to the training of Indian scientists which Prof Agharkar got straightened out was regarding the award of overseas scholarships of the London exhibition of 1851 Indian princes and several Indians had contributed to the funds for these scholarships of 1851 exhibition No benefit, however, accrued to India which the other dominions of British Empire were having He, therefore,

Professor Shankar Purshottam Agharkar

made a full study of the available reports of the trustees of this fund and with the help of Sir Raghunath Paranjpye who was then a member of the Indian Council at London, got the matter moving He discovered that a scheme of scholarship of Indians was put up by the trustees as far back as 1891 and £ 65,000 were provided for it by His Majesty's government, but no Indian scholar was ever appointed Prof Agharkar followed up this matter assiduously and as a result, a series of Indian scientists started being selected for the award of overseas scholarships of 1851 exhibition, London Dr H J Bhabha, and Dr K R Surange, the present Director of MACS are among the recipients of this scholarship

Although Prof Agharkar retired from the Chair of Ghose Professorship of botany at Calcutta University in 1946, thoughts of a cozy life were farthest from his mind He had been thinking of starting a research institute and he had indeed been working towards it much before his retirement This culminated in founding of MACS in Pune in 1946 At this institute he was director and conducted several research schemes on mango, banana, oil palm etc

MACS an autonomous research institute, has been engaged in research activities in the field of biological sciences—both of basic and applied nature. The institute carried out research work on over 100 different projects during the year 1983 84 under its eight departments – Biometry and Nutrition, Botany Chemistry, Genetics and Plant Breeding, Geology and Palaeontology, Microbiology, Mycology and Plant Pathology, and Zoology The Botany Department in this institute was established by Prof Agharkar himself in 1946 He initiated studies on his favourite subjects like floristics, economic botany and plant geography Prof Agharkar's deep and thorough knowledge of Indian flora and his personal collection of valuable books journals and back volumes on various aspects of botany helped to enhance the knowledge of applied botany in academic curricula Incidentally, Prof Agharkar along with Prof H P Paranjpye first introduced in Pune the African oil palm (*Elaeis guanensis* L) which is a source of oil rich in vitamin A He also showed that these palms can thrive in conditions prevailing in Pune and can yield one million tonnes of oil per acre of compact planting

C Asok

The main building of the Maharashtra Association for the Cultivation of Science founded by Prof Agharkar

[illegible] sequenced

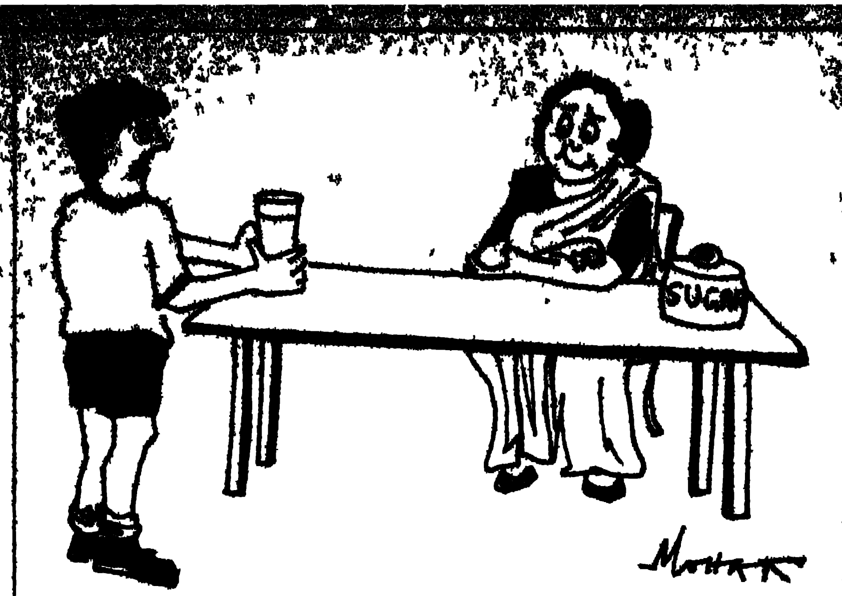
MOLECULAR biology is making [illegible] inroads in areas directly affecting man, especially clinical medicine. Several research groups are already working on prenatal diagnosis of diseases, cancer, drug production [illegible] development of vaccines While medical professionals are naturally getting excited as results start coming up, scientists are looking forward to taking up different disease causing organisms and literally tearing them to bits and pieces.

Two Cambridge groups now report the complete nucleotide sequencing (172 of 282 base pairs) of the Epstein-Barr virus (EBV). EBV was taken from a patient with infectious mononucleosis and was used to infect marmosets' (small, tropical American monkeys) lymphocytes producing the B95-8 line Tumour-promoting chemical inducers increased the amount of EBV secreted by this line. EBV was collected from the supernatant and the DNA was isolated Subsequently, it was cut with restriction enzymes and incorporated into plasmid vectors These plasmids were grown in *E coli* and many copies of each cloned restriction fragment of the EBV was isolated DNA sequencing method developed by Sanger was used to read off the base pairs on cloned pieces The 6 000 and odd pieces sequenced thus were then matched by a computer to determine their exact position in the EBV genome Hence the full linear array of bases making the whole genome of EBV was determined

This achievement holds out great promises for molecular biologists and clinicians Understanding the mechanisms of gene control by normal human DNA and by viruses does not appear far off, sequences of promoters, enhancers, and other signals that control DNA transcription into functional mRNA will soon be known Clinically, nasopharyngeal carcinoma, Burkitt's lymphoma and infectious mononucleosis known to be linked to FBV will now perhaps be easily diagnosed But above all, the complete sequencing of the EBV genome will make it possible for us to understand the molecular events leading to cancer formation

And, there is even scope for production of cheap and effective vaccines, for the knowledge of the DNA sequences implies that the various surface antigens expressed by infected cells can be characterised and peptide fragments made The peptide fragments are powerful immunogens against the proteins of which they are part and hence the vaccine production

What next, now that the EBVs genome structure is determined? Soon it will be the cytomegalovirus with 240 kilobase pairs of nucleotides, and then the bacteria *E coli* with 4,000 kbp and then perhaps even the human genome with three million kbp! For those who fear that the human genome may soon be manipulated by a genetic engineer sitting at a computer terminal, the solace is that the same Cambridge group who published the results of EBV sequences will need 5,000 years to determine the total human DNA sequences with the present technology! But who knows, if one has to go by the rapid developments of the past few years



"Some more sugar in my milk or I'll"

Sugar intake and child behaviour

FROM time to time, psychologists have put forward different scientific explanations for antisocial and violent behaviour in children Genetics, environmental factors, neurochemical abnormalities all seem to contribute in one way or the other towards abnormalities in children's behaviour And now, scientists have added high levels of sugar consumption to this list

Diet and human conduct seem to have a definite correlation Experts now believe that too much consumption of sugar makes children hyperactive and contributes to their anti-social behaviour To support this, Stephen J Schoenthler, co ordinator of the criminal justice programme of the California State College, observed that thousands of juvenile offenders showed a remarkable 50 per cent decline in antisocial traits when their diets were completely devoid of sugar foods But this change can also be produced by increase in vitamins and mineral content in the diet, cautions Schoenthler

So impressed are the civic authorities in Los Angeles with these findings that they have ordered the use of low sugar diet in all juvenile detention centres

Biggest telescope

THE American five metre reflector telescope on Mount Palomar in California will soon lose the distinction of being the world's largest The Tokyo astronomical observatory plans to build the world's biggest telescope It will be capable of observing the marvels of space 15 billion light years away!

The Japanese telescope will be a single lens reflector with an aperture of 7 5 metres and ten times larger in capacity Expected to be completed in 1990, Prof Keichi Kodaira and his group at the Tokyo observatory want to instal it on top of Mauna Kea, a 4,202-metre high peak in Hawaii Hawaiian peaks offer excellent weather conditions for optical observations and are already studded with telescopes installed by the US, Britain and France

DIGIT-BLOCK PROCESSING

THE concept of digit-block processing is a familiar one It has been described, with reference to the number 137 (see SCIENCE TODAY, September 1982 and August 1984) and to the number 73 (see SCIENCE TODAY, March 1983) If any natural number is multiplied by either of these factors of 10001 and the products so obtained are broken down into pairs of digit blocks such that one of the blocks is formed by the last two digits of the product, the sum of the squares of the pairs of blocks will always be divisible by the multiplier 73 or 137 as may be applicable

Thus, 1528 × 73 = 111544

$1115^2 + 44^2 = 1245161$ (17057 × 73)

$12451^2 + 61^2 = 155031122$ (2123714 × 73)

and so on.

When processing in this way, pairs of blocks in which one of them consists of the last four digits of the product, the factors of 100000001, namely 17 and 5882353, replace the multipliers, 73 and 137 By way of illustration, consider the number 142749, the product of 17 and 8397 It can be processed as follows

$14^2 + 2749^2 = 7557197$ (17 × 444541)

$755^2 + 7197^2 = 52366834$ (17 × 3080402)

$5236^2 + 6834^2 = 74119252$ (17 × 4359956)

and so on

There can also be other ways, however, of processing digit blocks, and one which reveals many interesting properties of numbers is that in which the difference between the squares of the blocks is considered instead of their sum

The multipliers 73 and 137 can be used in this system of processing in conjunction with pairs of blocks one of which consists of the last four digits of the product Consider, for instance, the product of 73 and 89987 namely, 65691021

$6569^2 - 1021^2 = 42109320$ (73 × 576840)

$9320^2 - 4210^2 = 69138300$ (73 × 947100)

$8300^2 - 6913^2 = 21100431$ (73 × 289047)

and so on

For dealing in this system with pairs of blocks one of which consists of the last two digits only of the product, 101 may be used as the multiplying factor The number 9 also serves equally well

When, however, the number of digits in the terminal block of the pair increases to 3, there can be a much larger number of multipliers from which to make a choice Some of these are listed below:

3, 7, 11, 13, 21, 28, 33, 37, 39, 63, 91, 99, 111

Two of these, namely, 11 and 91, are of special interest to us as their product is 1001 which supplies the clue for dealing with blocks of a larger size The factors of 100001, namely 11 and 9091, for instance, serve admirably as multipliers when the latter of the pair of blocks consists of 5 digits Thus, for example,

9091 × 31 = 281821

$81821^2 - 2^2 = 6694676037$ (9091 × 736407)

$76037^2 - 66946^2 = 1299858453$ (9091 × 142983)

$58453^2 - 12998^2 = 3247805205$ (9091 × 357255)

and so on

In the same way, 11 and 909091 the products of 10000001 serve as multipliers when the end block of the pair consists of 7 digits

The number 11 which keeps appearing as the companion number in these cases is obviously itself very versatile In fact, when using it as a multiplier the product can be broken up into pairs of blocks in any manner one may choose

Consider 57618, the product of 11 and 5238

Now, $5761^2 - 8^2 = 33189057$ (11 × 3017187)

Again, $576^2 - 18^2 = 331452$ (11 × 3012)

Also, $618^2 - 57^2 = 378675$ (11 × 34425)

and $7618^2 - 5^2 = 58033899$ (11 × 5275809)

Another number which is equally versatile is 3

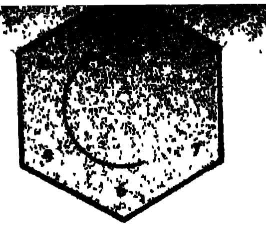
Here are a few extraordinary examples of this mode of digit processing

Direct recycling

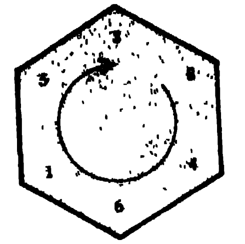
$1484^2 - 847^2 = 1484847$

Reversal of order

Starting number 7821



Circuit A



Circuit B

Processing $78^2 - 21^2 = 5643$

$56^2 - 43^2 = 1287$

Revolving numbers:

Here the same digits keep revolving maintaining their sequence The answers are all in the same circuit

Starting Number 714285

$714^2 - 285^2 = 428571$

$571^2 - 428^2 = 142857$

$857^2 - 142^2 = 714285$

Complimentary circuits

Here the answers keep on jumping from one circuit to the other and back again but retaining their sequence

$538^2 - 461^2 = 76923$ See Circuit 'A'

$923^2 - 76^2 = 846153$ See Circuit 'B'

$846^2 - 153^2 = 692307$ See Circuit 'A'

$692^2 - 307^2 = 384615$ See Circuit 'B'

$615^2 - 384^2 = 230769$ See Circuit 'A'

$769^2 - 230^2 = 538461$ See Circuit 'B'

A.R. Kanga

Mr Kanga is a consulting engineer based in Bombay

Multiplication of magic squares

AN interesting method for addition of 4 x 4 magic squares was presented by V S Risbud in SCIENCE TODAY, May, 1983 The same method can also be used for multiplication of magic squares (4 × 4) if the following steps are followed

Step 1 Find eight numbers, A,B,C,D, p,q,r, and s, so that A × B × C × D × p × q × r × s = X (X = multiplication magic constant)

Step 2 Write two square arrays, one containing only A,B,C, and D, and the other only of p,q,r and s as shown

$$\begin{array}{cccc} A & B & C & D \\ C & D & A & B \\ D & C & B & A \\ B & A & D & C \end{array} \quad \text{and} \quad \begin{array}{cccc} p & q & r & s \\ s & r & q & p \\ q & p & s & \\ r & s & p & q \end{array}$$

(Each row, column and diagonal is made up of the same four numbers, each letter occuring only once)

Step 3 Multiply the two arrays, element by element We get

$$\begin{array}{cccc} A \times p & B \times q & C \times r & D \times s \\ C \times s & D \times r & A \times q & B \times p \\ D \times q & C \times q & B \times s & A \times r \\ B \times r & A \times s & D \times p & C \times q \end{array}$$

This gives the product of two magic squares

If the value of any letter is zero then multiplication magic constant is zero The following example can be used for the multiplication of two magic squares (multiplication constant is 24024)

$X = A \times B \times C \times D \times p \times q \times r \times s$

A	B	C	D	p	q	r	s
1	2	7	13	1	3	4	11

Biswanath Das

Mr Das is doing graduation in science at Calcutta University

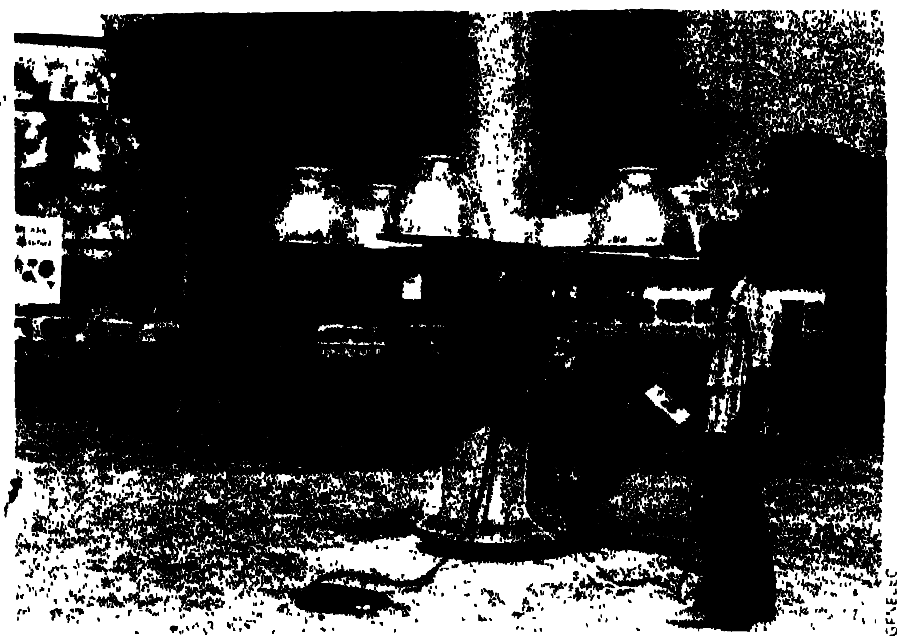
NEW LIGHT ON ELECTRIC LAMPS

Sylvestar Lobo

COURTESY GENELEC

IT is a long way since the first carbon-filament lamp was invented more than 100 years ago. When Thomas Alva Edison successfully demonstrated his incandescent lamp in the USA on 21 October, 1879, people looked at it as a miracle. Since then work on improving the lamp progressed slowly, though steadily.

Edison's lamp was improved upon in 1902 by the introduction of osmium filament and in 1907 by tungsten filament. Argon gas fillings and coiled filament resulted in more efficient lights in 1913. The low-pressure sodium lamp appeared in 1932 and high-pressure mercury lamp in 1935. While the introduction of tubular fluorescent lamps in 1939 was a



GENELEC

Fig. 1 *A few units of high mast lighting are capable of illuminating large areas* **(above).** *Fig. 2 The lantern carriage of high mast lighting is brought down for maintenance using motorised winch-down device* **(left)**

hallmark in general lighting, the high pressure sodium lamps which came into market in 1965 proved a boon to road-, factory- and floodlighting.

But the energy crisis in the 1970s precipitated the need for more efficient and economical light sources. With the worldwide shortage and the resulting higher costs of electrical energy, scientists were forced to look for energy-effective lighting devices. And today a variety of electric lamps are available. Have they proved successful? Do we have lamps that save energy as well as last long? What are the latest developments in the field of electric lamps?

The most promising event is the discovery of miniaturised fluorescent lamps. These, as we shall see, combine efficiency with energy saving and last much longer than any of the present lamps. No doubt, they are heavy on the purse presently. But their ability to pay back the initial investment by drastically reducing energy bills should make them popular. And when they are mass-produced they should be within everyone's reach.

Replacing incandescent lamps

One of the new compact low pressure mercury fluorescent lamps (LMFL), complete with its control gear (Fig 4), is contained inside a glass bulb and fitted with a conventional incandescent lamp cap. It can be used directly in place of an incandescent lamp on the same base. It consumes only 25 per cent of the energy that an incandescent lamp of comparable light output would consume.

Like the incandescent, the LMFL has a warm white-colour appearance and gives good colour rendering (a property of light by which we perceive various colours). Its lifetime, at 5,000 hours, is five times that of an incandescent. The

Fig 3 The first incandescent electric lamp (left) and the modern tungsten filament lamp (right)

lamp is available (not yet in our country) in two versions, one having a clear prismatic bulb and the other an opal bulb, each being made in four Wattages, 9, 13, 18 and 25.

The LMFL achieves maximum energy-saving because it is based on the principle of fluorescence: current is passed through an ionised gas and the resultant emission is converted into visible light by phosphor powders. This process is far more efficient than the process of incandescence.

In an incandescent lamp, light is emitted when a thin tungsten wire is heated. But there is a physical limit to the temperature that the wire will withstand, and hence the efficiency that can be obtained for a given lifetime. Also in the process of incandescence, small particles of the filament are driven off by the heat, that is, they evaporate. Since the LMFL operates like a fluorescent lamp this deficiency is not there, resulting in its longer life.

The LMFL is larger than an incandescent lamp. It approximately weighs 500 grams because it contains the ballast (device used with discharge lamps for stabilising the current in the discharge) and the starter, while a filament lamp weighs only 40 grams. So a sound lamp-holder is a must before fixing up an LMFL. Under normal conditions it lights in less than two seconds. Thereafter, the light builds up to 80 per cent full brilliance within one minute. In cold conditions it normally operates within four seconds.

The outer glass is not essential to the electrical operation of the LMFL but it makes the lamp easier to hold, gives it a better look and is a first line defence against knocks. It is also not water tight.

Where filament lamps are used for long hours and inconvenient situations, the LMFL is ideal because of its durability and energy-saving. An 18 Watt LMFL gives light as much as a 75 Watt ordinary bulb. It gives most of its light sideways where it is more useful unlike a filament lamp which distributes light in all directions, wasting light on the ceiling.

New bridge-welding concept

Another miniaturised fluorescent lamp (MFL) based on the principle of low pressure mercury discharge, consists of two narrow glass tubes welded together at the top (Fig 5). The purpose of this welding, which is totally a new concept, is to create cool spots since the light output of a fluorescent lamp depends upon the temperature of the coolest spot on the lamp, this temperature is influenced, among other things, by the ambient temperature. Since the bridge-welding process creates cool spots at the top of the tubes (in an ordinary tubular fluorescent lamp the cool spots are created behind the electrodes at either end) optimum light output occurs at higher ambient temperatures than normally experienced with straight and U shaped lamps. This is also an added advantage of an MFL as far as the design of luminaires is concerned.

Unlike the tubular lamps, the MFL has a single end with a starter built into the aluminium cap. This integrated starter ignites the lamp within two seconds for ambient temperatures between -5°C and 50°C.

Adjacent to the starter, the cap also has a capacitor to suppress radio interference. The two pin electrical connection needs a special lamp holder. However, efforts are afoot to make the MFL lamp kit, consisting of the lamp, lamp-holder, ballast and an adapter to fit the MFL with the ordinary household lamp cap, available in the country.

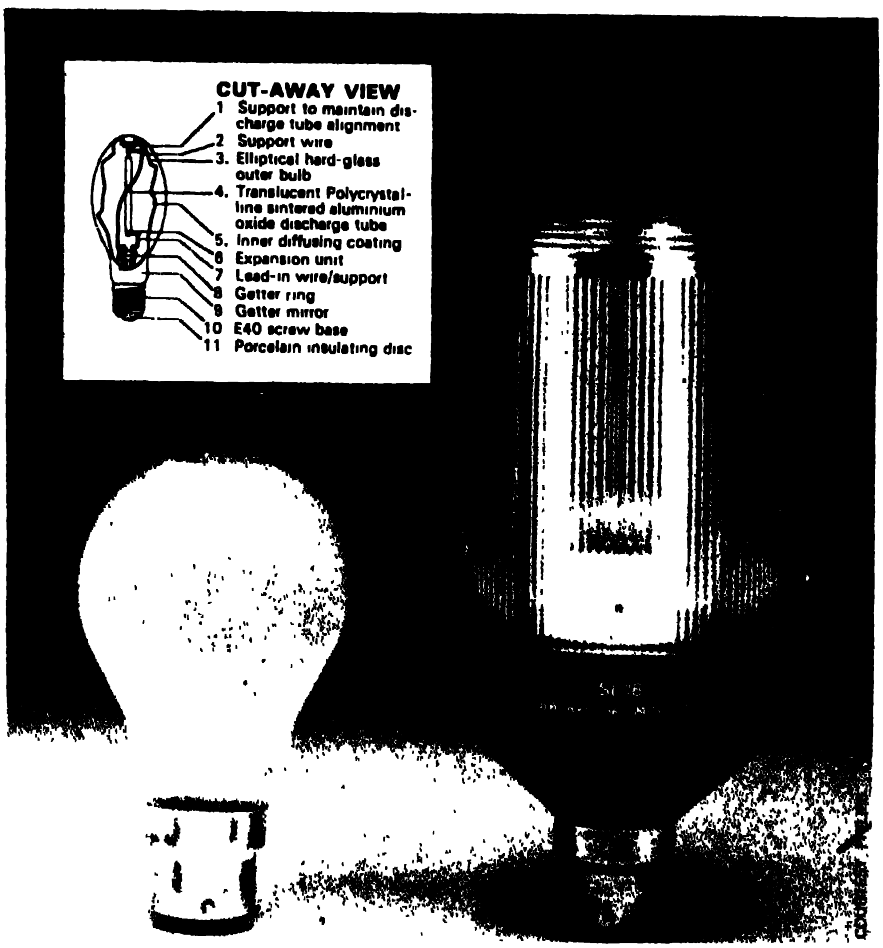


Fig 4 The new compact fluorescent lamp (right) which can directly replace an ordinary incandescent lamp (left). Inset: The internal structure of a high-pressure sodium vapour lamp

The 7, 9 and 11 Watt MFL lamps with light output of 400, 600 and 900 lumens respectively, can be compared to 40, 60, and 75 Watt incandescent lamps. Thus they are five times more efficient than incandescent lamps. They are also more durable with a life of 5,000 hours while the incandescent lamps last not more than 1,000 hours.

The MFL which is available in the country can be used in houses, hotels, offices, museums, theatres and so on. Recent developments have also shown that it can be used in ships and other means of transport where energy is generated on the spot besides in vending and amusement machines, insect traps and outdoor lighting in residential areas.

Energy-efficient incandescent lamps

While the new compact fluorescent lamps can replace incandescent filament lamps with advantage, there are new developments in the latter category itself which combine energy saving with efficiency. For instance, the reflector incandescent lamps which have an internal mirror-coating, give a beamed light distribution. There is no spilling of light here and it is directed to areas where it is desired so that there is an efficient use of energy.

Similarly, the directional mushroom lamp gives a diffused wide beam downwards while directing some light upwards. It gives more useful light down, as compared to the clear incandescent lamps.

High voltage incandescent light installations can be modernised using blended light lamps, which have twice the efficiency and almost six times the operating life, at no extra cost. These lamps consist of a gas filled bulb coated on its inside with a phosphor and containing a mercury discharge tube connected in series with a tungsten filament. The mercury discharge has ultraviolet radiation which is converted into visible radiation by the phosphor coating. The incandescent filament gives out warm-coloured light, it also acts as a ballast for the discharge, thus stabilising the lamp current. Therefore, blended-light lamps can be connected directly to the mains.

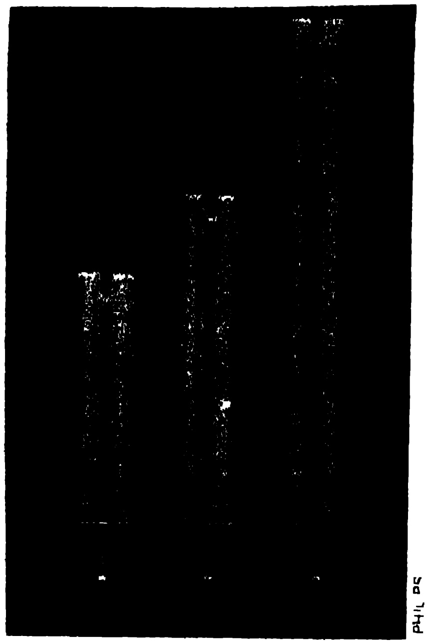


Fig 5 The miniaturised mercury fluorescent lamps in 7, 9 and 11 Watts. The new concept of bridge-welding enables them to function efficiently and last long

If these developments have made incandescent lamps energy efficient, and the LMFL and the MFL have brought about a vast change in the domestic and professional lighting scene, the high-pressure sodium lamp has improved road, factory, and floodlighting to a great extent.

Golden white light

The high-pressure sodium lamp (HSL) with its golden white light is the most efficient light source now available in the country. It requires a ballast, an electronic ignitor and a capacitor as accessories for optimum performance.

The discharge tube of the lamp contains an excess of sodium to give saturated vapour conditions when the lamp is burning. An excess of mercury is also present to provide a buffer gas and xenon is included at a low pressure to facilitate ignition and limit heat-conduction from the discharge arc to the tube wall. The discharge tube, which is made of sintered aluminium oxide to withstand the intense chemical activity of the sodium vapour at the operating temperature of 700°C, is housed in an evacuated protective hard glass envelope.

These lamps radiate energy across a good part of the visible spectrum and give good colour rendering. They are available in ovoid or tubular shape and are ideal substitutes for high-pressure mercury vapour lamps. The HSL is extensively used for indoor and outdoor industrial lighting, in warehouses, godowns, parking areas, docks, storage yards, floodlighting highways, streets, flyovers, junctions etc.

High mast lighting

Electrical engineers, meanwhile, have also designed modern equipment to use lamps like the HSL in high mast lighting which is essential for city centres, motorway intersections, flyover complexes and all industrial and commercial areas. These require a high standard of lighting from relatively few installations.

Such installations are now available with masts of 20, 25 and 30 metres height. The masts, which should withstand high wind speeds, are manufactured from steel plates, cut and folded to form polygonal hollow poles. Each mast comprises only two or three sections according to height, to minimise the number of horizontal joints. These sections can be fitted together at site without welding and erected with the help of a crane.

To service electrical lamps hoisted on these high masts, designers have come up with motorised winch down device (Fig 2) which brings down the lantern carriage to ground for inspection and maintenance. This avoids the dangerous climbing, ladders or tower wagons needed otherwise to service such lamps.

These are then a few prominent developments among many in recent times. However, one fact that stands out is that research in electrical lamps hasn't been spectacular as it is in the space or communications industry. In our country such efforts are almost minimal. While the MFL may be manufactured here soon, the LMFL may take a long time. The poles required for high mast lighting were so far imported. The first indigenous high mast is under installation in Chembur, Bombay. So it is a long way for us to go still. □

New Life for Old Paintings

O.P.Agrawal

The ornate portrait of the Nawab had adorned the walls of the Picture Gallery in Lucknow But over the years the painting had acquired a yellowish tinge and a dull look, and nobody knew the 'true colours' of the painting - until the restorer removed the yellowing varnish on the painting That brought the lustre back into the diamonds and rubies worn by Nawab Wajid Ali Shah What was more, it revealed the name of the artist which was not known till then

Over a long period, paintings tend to deteriorate and need to be restored for which several techniques have been developed Let us first discuss the structure of a painting, how it is made, the composition of its various constituents and how it deteriorates, and then the broad outlines of these conservation techniques.

A painting has at least two layers-- the 'support' on which the painting is done and the other, the 'paint', that is, the colouring material In a wall painting, the 'support' is the wall or the plaster on which the paint is applied, in a wooden panel painting, it is the wooden panel, and in a paper painting, it is the paper The second essential component, the paint, is prepared by mixing pigments (colouring materials) with adhesives like gum, glue, resin or oil, these adhesives are called the 'binding media', which fix the pigments on the support

Besides these two basic layers, the support, before it is painted upon, was often coated with a thin layer of a putty-like substance known as 'gesso' to impart a smooth and fine finish to the surface This layer is known as *ground* or *priming* Normally a white material like chalk or kaolin was mixed with a binding medium to prepare 'gesso' In miniature paintings, the paper as well as the priming was well burnished with agate stone to give it a shiny smooth surface This enabled the artist to draw fine lines, a characteristic of Indian miniature paintings (Fig 3)

When the painting was ready, transparent varnish was coated, particularly on oil paintings, to protect the painting from the effects of atmosphere and moisture On paper paintings, however, varnish was seldom, if ever, applied Figure 2 presents in a

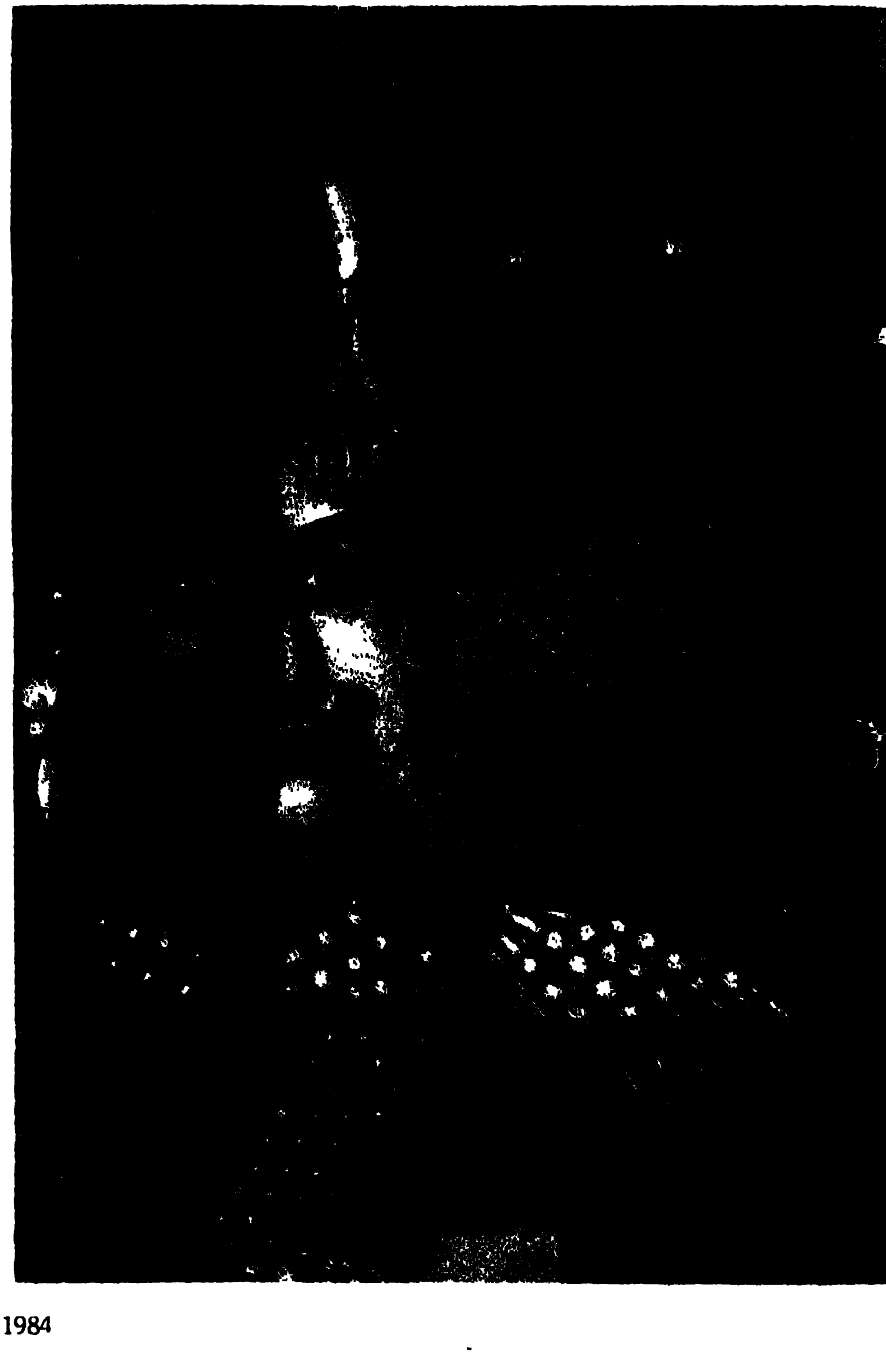


Fig. 1 A painting of Nawab Wazid Ali Shah in the Picture Gallery, Lucknow The varnish had yellowed considerably and had changed the tonal values of the underlying colours The varnish had to be removed to restore the painting to its original tonal values. The picture at right shows the difference between the portion from which varnish has been removed (left half of the face) and where the old varnish is still present. At right is a painting which has developed cracks

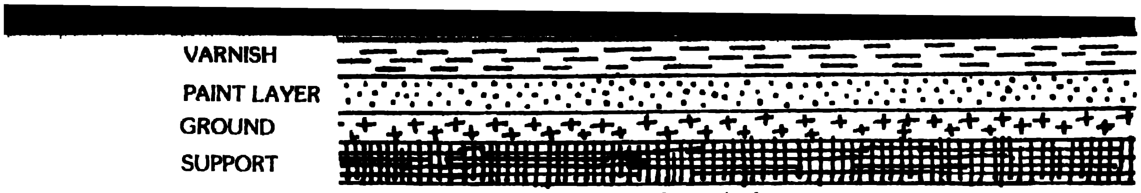


Fig.2 The structural layers of a painting

schematic form the various structural layers of a painting

There may be several variations in this basic structure For example, the paint may have been applied in several layers, it may be thick or thin, it may have received an undercoat of another colour, depending on the artist's style [illegible] artists added a *glaze* to the surface of the paint to impart a lustre to it

Surface defects

The traditional coating for a painting is varnish prepared by dissolving or fusing a natural resin in a fluid Several kinds of resins, most of them plant products, were used earlier to prepare picture varnishes But shellac, which was very commonly used in India, is produced from the secretions of the insect, *Laccifer lacca* Now synthetic resins are also very popular Resins have been broadly categorised as hard and soft Hard resins have to be melted and mixed with a liquid like oil at a high temperature for them to be brushed on a painting, examples are copal and amber, both fossil resins Varnishes prepared with them are strong, very hard and difficult to dissolve when they are dried Soft resins like mastic, dammar and shellac can be dissolved in an organic solvent like turpentine or alcohol

When varnish is applied on a painting it is more or less clear and transparent, almost like glass. With age, however, it starts changing The first important change is in the colour, its clarity is lost and it acquires a yellow or brown tinge In extreme cases, it may become rather opaque, hiding under it the details of the painting. How fast these changes occur depends upon the type of the resin and on the conditions in which the painting is kept

The result, however, is a marked change in the appearance of the tonal values of the colours The yellowed varnish acts like a yellow filter over the painting and thereby gives an illusion of blue appearing as green, red as orange, white as yellow and so on. Further, the darkened varnish hides the details of the painting

Another defect noticed in the surface coating is the accumulation of dirt or grime over it Dust particles which fall over the surface may get stuck to it and change the visual impact of the painting Sometimes the varnish acquires a white cloudy look known as 'blooming', the causes for which may be chemical as well as physical Or the surface coating may develop cracks in it, for the varnish,

Fig 3 A miniature painting

Whatever may be the anatomy of a painting, one thing is certain: it starts deteriorating soon after it is ready Possibly for the first few months, it is perfect--the canvas is tight, the paint is flexible and the varnish is transparent But soon changes begin to take place The oil of the paint starts getting oxidised and hardened. The canvas or the paper also deteriorates The change is fast or slow, less or more, depending upon the materials used, the techinque of painting and the environmental conditions. In each layer of the painting-- the surface, the paint and the support--one can expect some changes to occur.

Over a long period paintings tend to deteriorate and need to be restored for which several techniques have been developed

which is initially smooth and transparent, may gradually lose its flexibility. Besides, one may also find scratches and blemishes on the varnish surface, a sign of accidental, and sometimes deliberate physical damage (see cover) There is a tendency among some visitors to touch a painting and in that process they may scratch the varnish or sometimes even the underlying paint

When any of these happens, the only way is to remove the varnish from the painting This is done by dissolving the old resin in a solvent By careful examination a mixture of solvents is tried Naturally, it must be such that it will dissolve the varnish but will not affect the underlying paint Due consideration has also to be given to the strength of the paint and of the ground The work is normally accomplished under a magnifier or under a stereomicroscope At each stage of cleaning, the restorer has to be sure that no trace of the paint is being dissolved After the old varnish is completely removed, a new varnish coating is applied

Cleaning the varnish sometimes produces spectacular results For example, when a portrait of Nawab Wazid Ali Shah in the collection of the Picture Gallery, Lucknow, was cleaned by restorers of the National Research Laboratory for Conservation of Cultural Property, it revealed the signature of the artist which was not visible earlier The removal of varnish also brought out the true tonal values of the colours of the painting (Fig 1 and cover)

The cleaning process, however, gives rise to some difficulties also Visitors who are used to seeing the painting with the altered colours are shocked to see the change when the discoloured varnish is removed In many a case, the restorer is blamed for 'ruining' the painting

Paint defects

The development of cracks are the most common defect in the paint surface (Fig 1 inset) The physical and chemical properties of the paint and the support are not similar For example, while the wooden panel or the paper is hygroscopic and absorbs moisture when kept in high humid conditions and shrinks in a dry environment, the paint - size remains the same The result is a conflict between the paint and the support, causing cracks in the paint Very fine cracks are the sign of age and are known as 'craquelures'

There may be other causes too For example, a weak binding medium may lead to cracks And so also shocks or vibrations to the support, scratching of the surface, an accidental blow from the back or continuous abrasion against a hard surface Flaking or loss of paint particles (Fig 7) follows crack-formation In cloth paintings, frequent rolling and unrolling may cause loss of paint

The first step in tackling this problem is the correct diagnosis of the causes If cracks have been caused by environmental changes, conditions in which the paintings are exhibited or stored should be stabilised If the cause is the failure of the binding medium, an appropriate adhesive is

introduced between the paint and the support. In canvas paintings, the adhesive is applied from the back of the canvas till it penetrates to the other side. This cannot be done for paintings on paper or on wood. In paper paintings, the paint is normally

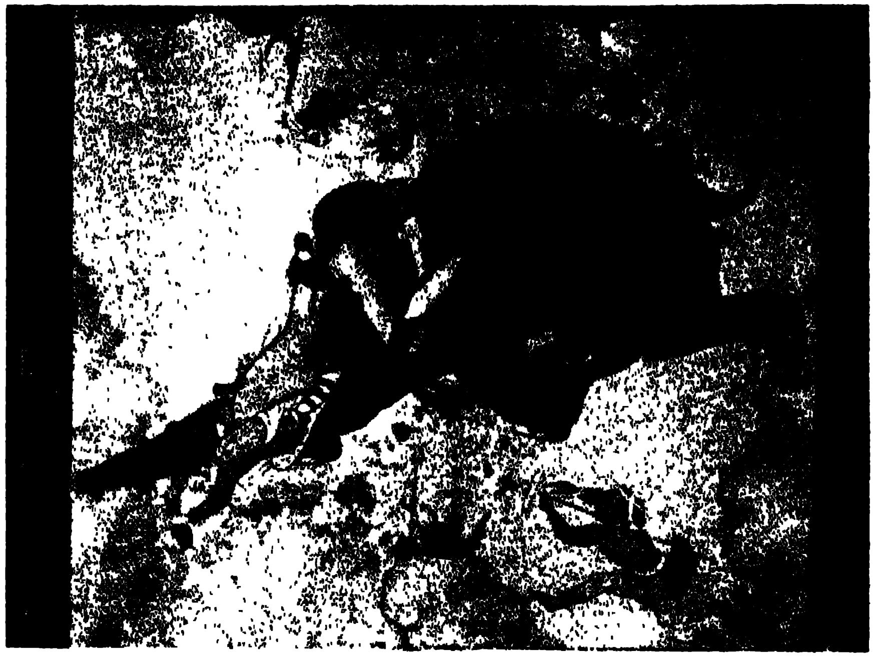


Fig. 4 (facing page) A paper painting eaten by insects

Fig. 5 (right) A paper painting with deep coloured water stains

Fig. 6 (below) A painting badly damaged by the growth of fungi

thin and, therefore, the new binder is applied from the surface, and so also in wooden panels when the paint is thin; if it is thick, like in an oil painting, the adhesive is sought to be introduced with the help of a hypodermic syringe in between the paint and the support.

For areas from which the paint has completely flaked off, nothing much can be done except to fill the gaps with a putty prepared with a whiting material and a binding medium like glue. The putty of an appropriate consistency is filled in the lacunae with a pointed spatula and allowed to dry. It is then smoothened to the level of the painting and then retouched to match the surroundings.

Another defect of the paint is its fading, generally caused by the action of light. Light, particularly ultra violet, causes fading of colours. Miniature paintings and water colours are much more sensitive to light than oil paintings. The paint medium like gum, glue, oil or egg is also damaged by light. Once the colours fade, nothing much can be done about it, except preventing further fading by modifying the light source: the ultra violet portion of light can be easily filtered off without affecting visibility in a museum. Daylight has the highest proportion of ultra violet rays and is avoided as far as possible in painting galleries. Fluorescent lamps also have ultra violet radiations, though less than in daylight, and therefore an ultra violet filter has to be used over them.

Tungsten light, on the other hand, has a very little portion of ultra-violet rays

It is better to minimise the intensity of and exposure to visible light also Only as much light as is necessary for viewing a sensitive painting is allowed in the painting gallery Some museums take the precaution of switching off the lights when there is no visitor inside

Another defect that may be noticed in the paint is a change in the colour, the most common example being the blackening of the white lead carbonate pigment In contact with sulphide gases, lead carbonate changes to lead sulphide which is black. Similarly, red lead also may get blackened Another paint which often changes to black is silver. Orignally-shining silver foil or silver powder is tarnished, changing to silver sulphide Treatment with a solution of hydrogen peroxide often restores the white colour of lead carbonate With this treatment, the black lead sulphide is oxidised to lead sulphate which is white in colour

Support defects

Since canvas, cloth, paper and wooden panels are the most commonly used supports, we will consider the defects in these materials Cloth or canvas were very popular painting-supports For cloth paintings, there are two distinct situations according to which the treatment differs One is where oil is used as a binding medium, these paintings are referred to as 'oil paintings' or simply as 'canvas paintings' In the other, the paint is mixed with an aqueous binding medium like gum or glue, such is normally the case with the Indian *patachitra* or the *pichhvai*

Whatever the binding medium, the cloth deteriorates with time It may lose strength, and tears and holes may appear, maybe because of accidental damage or because of the action of certain pigments and dyes on the cloth, particularly in the Indian *patachitra* Any acidic pigment may cause such a damage

If the cloth on which the painting is done is otherwise strong, with only a

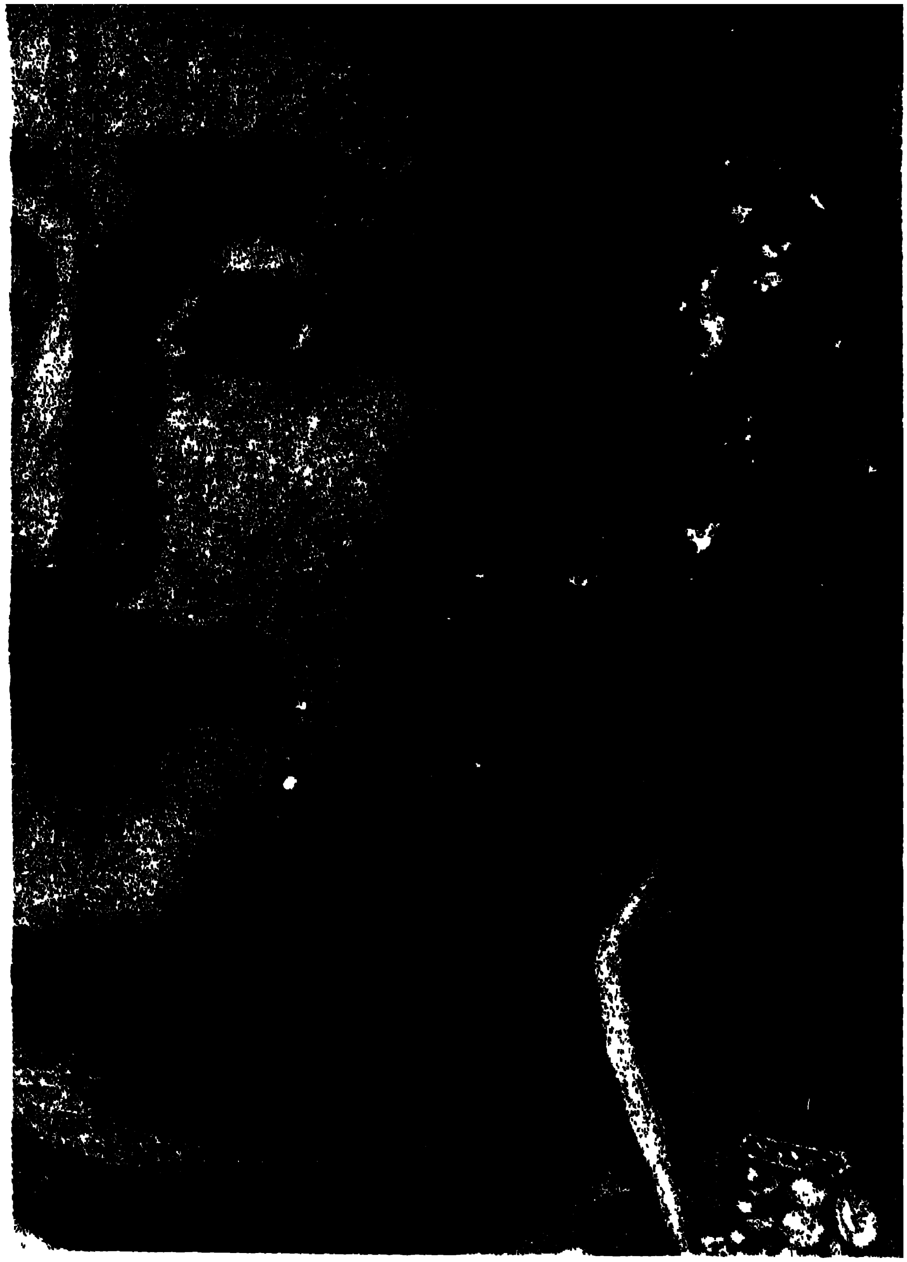


Fig. 7 (above) The paint layer in this painting is cracked and flaked

Fig. 8 (below) A wooden panel heavily infested with insects. The paint is still intact but will be destroyed if insect attack continues

Restoration of paintings is a complicated process involving as much artistic skill as scientific knowledge

few holes and tears, they are repaired by pasting strips and patches from the back But the adhesives used must be compatible with the original paint For oil paintings, for instance, a mixture of wax and resin is commonly used, for Indian cloth paintings, starch paste is preferred The adhesive should not ...e any strain or stain on the surface of the paint or on any other component

Canvases which have become totally weak and fragile are strengthened by pasting another cloth of a suitable thickness on the back The process is known as *lining* If there already was a canvas attached, it is first removed from the back of the painting and a new canvas is fixed

The other common defects in a cloth painting are the presence of stains, growth of fungi and insect attack Growth of fungus is promoted mainly by high humidity in the surroundings If fungus is noticed on paintings, immediate fumigation with a fungicide, like thymol, is called for Oil paintings, however, cannot be treated with thymol because the chemical has a softening effect on the oil The paintings are kept inside air-tight fumigation chambers in which thymol crystals are placed There is an arrangement for heating the thymol crystals from outside The thymol vapours surround the object and 'kill' the fungi The dead fungus is then brushed off the painting

In paper supports, the main defects are the formation of stains, the presence of acidity, the growth of fungus, insect attack and a general weakening of the paper Paper is easily stained Even water in contact with paper produces deep coloured stains difficult to remove (Fig 5) Stains may also develop due to oil, general dirt, rust, wax and other similar substances For removal of stains, various solvents are used, but they should not affect the paint in any manner Bleaching has sometimes been recommended for miniature paintings This, however, is dangerous because it may affect the paint also

Acidity in paper is extremely damaging Acidity may develop because of the acid used in the manufacture of the paper or it may be one of the degradation products of a constituent of the paper Neutralization or deacidification of acidic paper paintings is, therefore, very necessary However, there is always a danger of the paint being damaged by the solution that is used for neutralization Non-aqueous deacidification solutions, like a solution of barium hydroxide in methanol, are preferred but they only neutralize the acidity and do not remove the acidic products Vapour phase deacidification is also done but this process also suffers from the same disadvantage

Paper is also prone to fungal attack (Fig 6) Studies indicate that the most common fungus species growing on paper paintings are *Aspergillus niger*, *Aspergillus fulvus*, *Alternaria alternata*, *Penicillium citrinum*, *Cephalosporium acremonium* and *Fusarium oxysporum* (SCIENCE TODAY, December 1983, p 10) For prevention of fungal growth, stagnation of air should be avoided Fumigation with thymol vapours can eradicate fungus

Paper paintings are also damaged by insects which tunnel holes in them and weaken them considerably (Fig 4) To deal with insects, treatment with insecticides, particularly fumigation, is resorted to

With time, paper also loses its strength Weak paper paintings are repaired by 'lining' with a fresh paper sheet The process of 'lining' varies for example, paintings may have been done on both sides, or there may be an inscription or a text on the other side of the painting

For repair of only tiny holes often a result of insect attack, a putty of paper fibres is filled in the holes and allowed to dry Larger holes are repaired with sheets of paper out of which a piece of appropriate size is cut and fixed in the hole And if the entire paper is weak, 'lining' with a new paper support will be necessary But the choice of the supporting paper and a good adhesive are crucial Tests indicate that the Nepalese tissue paper is very strong and durable for the repair of Indian miniature paintings It has long fibres, has high folding endurance before and after ageing and is non-acidic The other type of paper suitable for such lining is the Japanese mulberry tissue paper It also has a high durability Some Indian handmade papers are also being tried for lining of miniature paintings

Wooden panels

Wooden panels or boards are some of the earliest materials to be used for painting Large-size boards are obtained by joining several boards together One of the common problems is that they split or separate The panels also warp, particularly in a painting in which one side of the panel is covered with paint and thus impedes the absorption or release of moisture from that side

The restoration and preservation of paintings is, indeed, a complicated process involving scientific knowledge and artistic skill Paintings can be lost irreparably if proper materials are not used for repair Much more important is the skill of the restorer Immediately after restoration, the painting may start looking new but may give rise to problems after sometime

Described above are only a few processes of preservation of paintings There are still a large number of outstanding problems Experiments are underway in the National Research Laboratory for Conservation of Cultural Property, Lucknow, and in other laboratories for finding a solution of these problems □

Mr Agrawal heads the National Research Laboratory for Conservation of Cultural Property, Lucknow established by the Department of Culture Government of India, and sponsored by the United Nations Development Programme He is a Fellow of the International Institute for Conservation of Works of Art London and the President of the Museums Association of India and the Indian Association for the Study of Conservation of Cultural Property

Dental caries is preventable

DOCTOR, *what is dental caries?*
Dental caries, or cavities as they are called in lay man's language, or tooth decay is a pathological process of localised destruction of tooth tissues by microorganisms. It is indeed paradoxical that teeth can be destroyed relatively rapidly in a living man but are indestructible *post mortem*.

Is it true that the western population suffers from more dental cavities than our Indian population?
This situation is no longer true today. Sweets and chocolates were abundantly consumed by the westerners immediately after the Second World War and consequently there was a significant increase in dental caries rate. However, this situation has since been corrected by effective preventive measures.

As opposed to this, the increasing consumption of sweets by Indians and the lack of proper oral hygiene and other preventive measures has given India one of the highest prevalent rates for dental caries today. This is true of people in all classes of society.

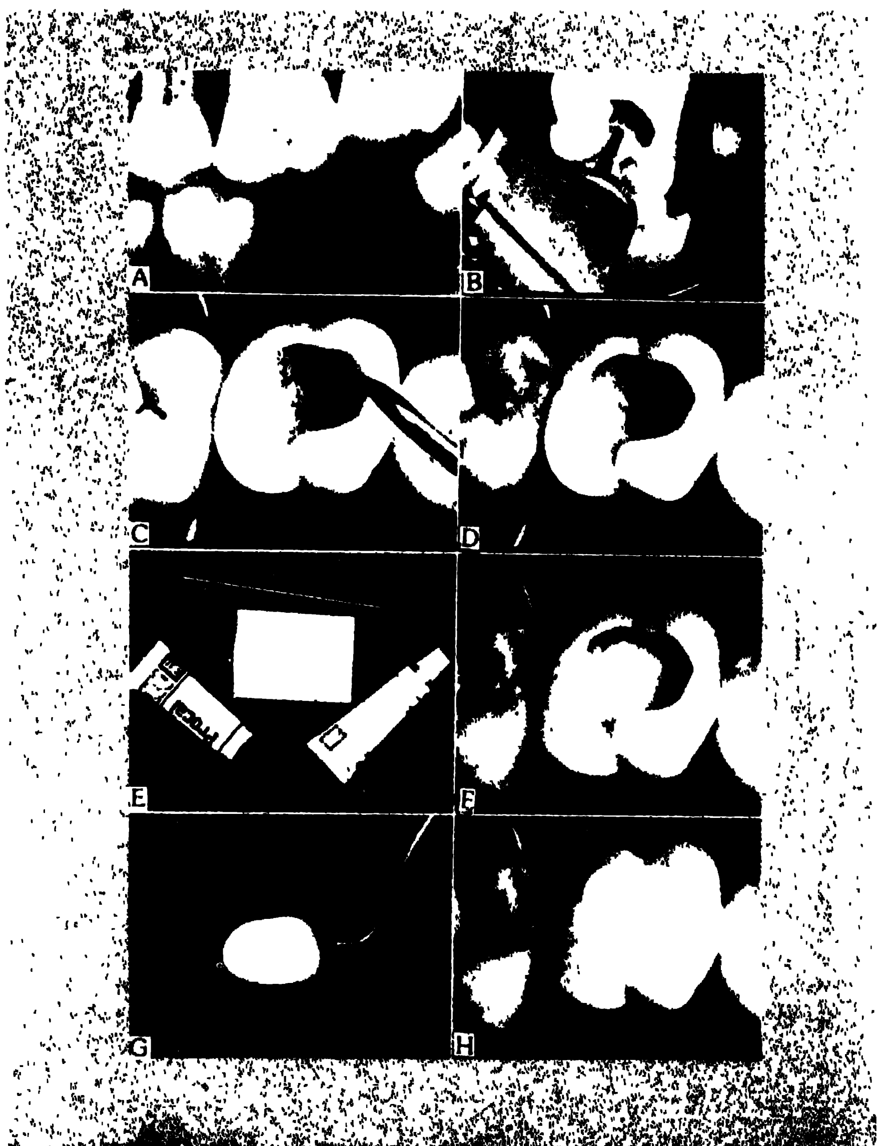
Doctor, but how are dental cavities formed?
Demineralisation and destruction of the calcified hard tissues of the teeth is brought about by acids and enzymes. The latter are produced by bacteria from fermentable carbohydrates like sugars (sucrose) consumed in the form of sweets, chocolates and biscuits.

How can I prevent the formation of dental cavities in my children?
The first point to bear in mind is to reduce their consumption of sugar, especially in between their meals. By sugar I mean, sweets, toffees, chocolates and the so called *glucose biscuits*. I am emphasising glucose biscuits because many parents do not know that these glucose biscuits are full of fermentable carbohydrates like glucose and sucrose which stick in children's teeth. This keeps acid in contact with the teeth for a longer time.

And to think that I always encouraged my children to eat glucose biscuits ... ?
The second tip would be proper oral hygiene. Teeth should be brushed, both morning and, especially at night with a *fluoride* tooth paste. A good tooth-brush and correct brushing technique is very important. Finger rubbing with a paste or powder is not effective since the finger cannot remove the sticky bacterial plaque which form on the teeth in the presence of sugar. Since the brush cannot go between the teeth one should use dental floss, which is available at all chemists' shops.

You should also try to visit your dentist every six months and get a thorough check-up and cleaning of your teeth. During this visit the dentist can also detect small incipient caries and take timely action. Children should also get six monthly or yearly fluoride application to their teeth by their dentist so that the enamel can be made resistant to the action of acids.

Children should also be taught to rinse their mouths with plain water after consumption of any food item and even after a cup of tea or coffee, or a glass of milk, more so if there is sugar. I know, this practice is not widely followed by urban people, but the sugars present in food items and in fluids can do irreparable harm to your teeth. If it's not possible to rinse your mouth, as in a party or at school, one should just take one or two gulps of water



Various steps in the removal of the diseased (carious) tooth substances and the temporary restoration of the tooth (A) Indentifying a carious tooth, (B) Drilling at slow speed to remove caries, (C and D) Removal of caries; (E to H) show different steps in temporary tooth restoration with reinforced ZnO cement

and try to wash off the food particles from the teeth

Doctor, what is this bacterial plaque?

Dental bacterial plaque is a transparent sticky mucinous substance formed from sugars by certain oral bacteria, namely *Streptococcus mutans* and *Lactobacillus acidophillus*. It consists of bacteria and food debris intermingled in a network of ...cinous polysaccharides. The dental plaque produces a considerable amount of acids and these acids are prevented by the plaque from the neutralising action of saliva. This is the reason why daily removal of the dental plaque is so important for the control of both dental caries and gum disease.

You also mentioned the use of dental floss. What is it?

Dental floss is a piece of braided nylon cord which is wrapped round the middle fingers and then gently eased between the teeth. The plaque is removed by scraping the floss against the sides of the teeth.

Doctor, is there no chemical which will prevent the formation of dental plaque?

Well, there is a chemical known as "chlorhexidine" which has been shown to prevent the formation of dental plaque. However, although most studies have shown it to be relatively safe even on prolonged use, I would not advocate chlorhexidine or for that matter any chemical for prolonged use in the oral cavity. If at all, it should be used under medical supervision as a mouth wash after oral surgical procedures, especially when brushing and flossing may be difficult.

I have heard that fluoride tablets are now available in India. Are they at all useful?

Yes. If the fluoride tablets are given to children at the time of development of their teeth, fluoride would have a systemic action and combine with the enamel when it is forming and make it more resistant to caries. Sucking or chewing the tablets by a child also has a local action on the erupted teeth.

My neighbour's child of only two years has huge cavities in nearly all her milk teeth, including her front teeth. What can bring about such a condition?

The condition you are describing is known as rampant caries. Though the exact reasons are not known yet, some authorities attribute this condition to the use of milk bottle, especially at night and allowing the child to go to sleep with the milk bottle in its mouth. The milk (worse if it is sweetened with sugar) stagnates all round the teeth where bacteria multiply

***The critical areas to be cleaned during brushing teeth are the gingival sulcus (gum region) and the interproximal areas between two teeth. Holding the tooth brush at a right angle to the tooth surface fails to clean the interproximal areas. Bristles at an angle of 45 degrees to teeth surface are more effective* (above)**

***Cleaning the teeth with floss in areas not easily reached by a tooth brush* (right)**

producing acids which finally destroy the teeth.

Recently I read in a magazine that you can prevent formation of cavities in teeth by sealing them with a plastic. Is this advisable?

Yes, it is definitely advisable and should be routinely practised by all dentists. Fluorides can dramatically reduce smooth surface caries, but it does not reduce caries in the pits and fissures of molars to that extent. In fact, its action here is negligible. Therefore, nowadays we seal the grooves in the permanent molars of children by a free-flowing plastic, so that the bacterial plaque cannot penetrate into the grooves and form a cavity. Studies have shown the plastic to stick to the treated tooth surface for as long as three to five years.

Doctor, what are the signs and symptoms which makes one aware of the presence of a cavity?

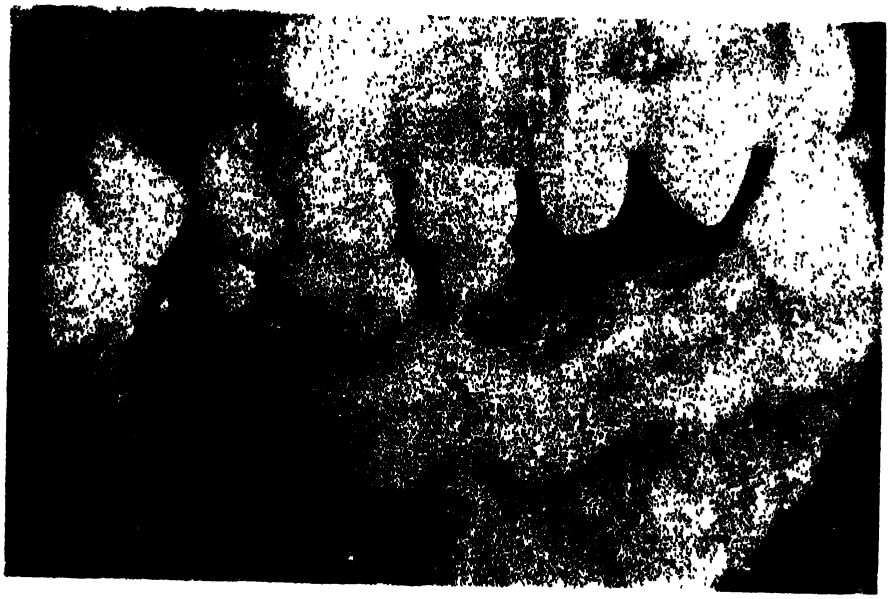
As I said before, you must get a check up of your teeth every six months by a dentist who can detect even a small cavity. If this advise is not followed then the earliest signal of a cavity, besides actually seeing a brown or a black hole in the tooth is a sensation of pain on consuming cold or sweet liquids or solids, food lodgement, either in-between the teeth or inside the tooth. However, I again repeat, do not wait for these signals to appear because often it may be too late to save the tooth.

What is the treatment once a cavity has already formed?

If the tooth substance has been invaded and destroyed by the bacteria, the only recourse for the dentist is to remove all the diseased, soft tooth substance (carious) and prepare the tooth (cavity preparation) for filling purpose. This is done by drilling so that the filling material (silver amalgam or composites) to be placed will be well retained in the tooth.

Doctor, these days one hears of so many tooth pastes, many being ayurvedic in origin. Which tooth paste will you recommend?

Primarily the tooth paste should have flourides in it and the latter is not present in any of the ayurvedic pastes and even in several allopathic brands. Secondly, the molecular size of the particles comprising the paste should be very fine. This is again not true of ayurvedic pastes. The coarse particles can destroy the enamel of the tooth. This is certainly not true of the allopathic brands, which even if not containing flourides, have fine granular size.



A three-year-old child suffering from "baby bottle syndrome"

Doctor, one last question please Since dental caries is caused by bacteria, is it not possible for scientists to prepare a vaccine against these organisms?

Your question is pertinent and I am happy to tell you that quite a few researchers, especially from the U K and USA are trying to develop immunity in the host (man) against attack by either the enzymes of the bacteria or the bacteria themselves responsible for caries A few of these workers are confident of developing a vaccine in the next five years, others are sceptical of an early breakthrough How ever, the vaccine against dental decay is still not anywhere on the horizon

P.S Turner

Dr Turner is attached to the Bhabha Atomic Research Centre Hospital, Bombay He has contributed to two textbooks on dental science besides having several publications

A COSMIC JOURNEY TO BLACK HOLES

George Mampilli

HEY are out of sight Nothing, neither matter nor energy, can escape from them Indeed, black holes are cosmic graves dug by massive stars From the diffused interstellar matter through stars, red giants, white dwarfs and so on to the most densely packed matter in black holes is an exciting cosmic saga

What is a black hole? A black hole is one of the simplest objects in the universe, essentially having only one property, namely, mass, and possibly spin and an electric charge whereas this page you are looking at is much more complicated It has mass, size colour, texture, molecules and atoms of different elements, positive and negative electric charges, motion and spin (of atoms), rigidity, temperature, elasticity, density and what not Each physical attribute makes an object more complicated But, since even a simple object may be made up of a number of simpler things, our quest for the black hole will be easier if we understand these simpler things

There are four basic forces in nature which can explain all the interactions of particles and their aggregates in the universe These, in the order of their intrinsic strengths, are the strong nuclear force, electromagnetic force, weak nuclear force and gravitational force All of us know what gravity is The gravitational force is what is responsible for the falling apple as well as planetary orbits In the Newtonian theory of gravity, the force of gravity between two objects increases when the total mass of these objects increases, and decreases as the distance between their centres increases

The weak nuclear force is what causes radioactivity of certain elements. Unlike the other forces, the weak nuclear force does not contribute directly to the cosmic events leading to the formation of black holes

Therefore, we will part company with it (The weak nuclear force has now been integrated with the electro magnetic force in the Salam Weinberg Theory)

The next is the electromagnetic force In its rudimentary form, it is the attraction between opposite and repulsion between like electric charges The atom is a perfectly balanced electromagnetic unit consisting of a positively charged nucleus around which one or more negatively charged electrons revolve at dizzying speeds The nucleus has two types of sub atomic particles protons and neutrons Of these, only the protons are positively charged while the neutrons have no charge For every proton in the nucleus, there will be an electron revolving around It is the interaction between the positively charged nucleus and the negatively charged electron which gives the atom its structure and volume

And finally we come to the strong nuclear force which holds the positively charged protons in the nucleus together in spite of the electro magnetic tendency to repel It is this tremendous force which is harnessed in nuclear reactors The strong nuclear force can be released either by splitting the atomic nucleus (fission reaction) as in the atomic bomb or by bonding together (fusion reaction) the nuclei of lighter elements to form a heavier element as in the hydrogen bomb

The hydrogen atom with one proton and an electron is the simplest and the lightest atom of an element Next is helium with a nucleus of two protons and two neutrons around which two electrons revolve In a hydrogen bomb, the temperature is initially raised to 4 million degrees Kelvin by a fission catalyst (atom bomb) when four hydrogen nuclei fuse to make one helium nucleus with the release of energy The mass of every resultant helium atom is minutely less than the mass of the four hydrogen atoms which went into its making It is this lost matter that is converted into the megatons of energy of a hydrogen bomb This transformation of matter into energy is governed by Einstein's famous equation, $E = mc^2$, where E, m and c stand for energy in ergs, mass in grams, and the speed of light in centimetres per second

Though gravity is incomparably the weakest of the four forces, what gives it the upper hand in the ultimate analysis is its pervasiveness While the strong and weak forces are confined to nuclear distances, the electro magnetic force is ineffective in macroscopic systems This is because matter in the large scale is electrically neutral

The birth of stars

From the microcosms, let us now go to some of the relevant simple facts of the macrocosms the birth, growth and death of stars, paving our way to black holes Though interstellar space is almost a perfect vacuum (an average of one atom per cc of space against 30 billion, billion atoms per cc of atmospheric air), this is the stuff

from which stars are born The distribution of this sparse matter in space is not uniform There are vast areas in space extending over tens of light years where gas and dust are present in relatively high densities The atoms in these clouds, consisting mainly of hydrogen, are swept closer together by galactic shockwaves when the spiral arms of a galaxy pass through these clouds Thereafter, the atoms come closer due to gravity During the subsequent contraction over millions of years, the temperature of this hydrogen globule steadily rises as the kinetic energy of contraction is converted into heat energy by the incessant collision of atoms, giving the sphere a dull red glow (Fig 1a) Since the force of gravity is maximum at the centre, the rate of contraction of this proto-star and, therefore, the increase in the temperature is also the highest at the centre Tens of millions of years after the gas cloud started on its inward journey, a moment of time is finally reached when the temperature at the core of the condensing mass rises to 4 million degrees Kelvin, starting hydrogen-burning, that is, fusion of hydrogen nuclei to form helium with the release of energy, as described earlier The energy output at the core of the proto-star from hydrogen-burning now produces sufficient heat and light for it to shine brightly by itself and enough outward pressure to counteract gravitational contraction And thus a star is born (Fig 1b) This is how 5 billion years ago our Sun was created

Of all the visible stars in the sky about 90 per cent burn hydrogen as their nuclear fuel The remaining, which have outgrown the hydrogen period, burn more exotic fuels or don't burn at all, and are given equally exotic names like red giants, white dwarfs and neutron stars Since, in the active life of a star, the period of hydrogen-burning is the longest, astronomers refer to stars in this phase of their life as being in the Main Sequence

The total time that a star remains in the Main Sequence depends on the

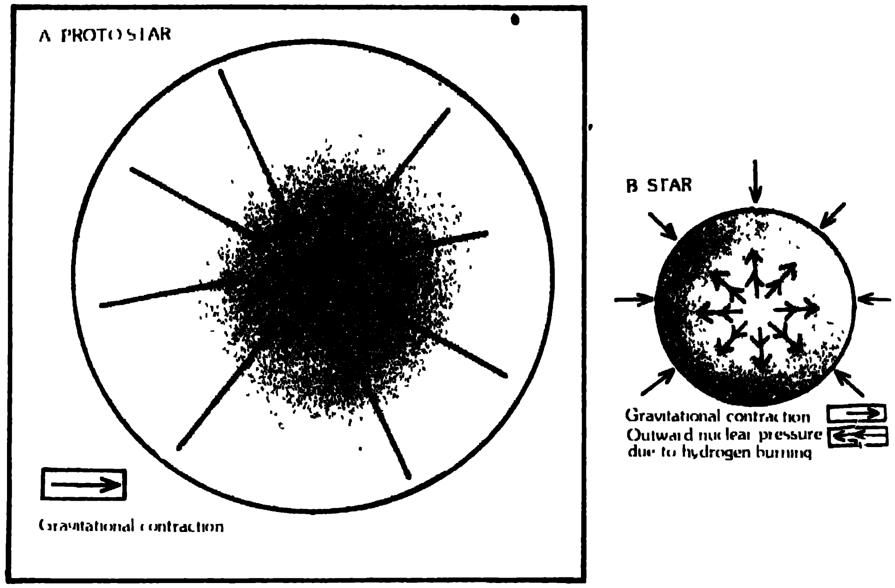


Fig 1 A cloud of diffused gas and dust (A) contracting due to gravity. After millions of years' contraction, it will become a star when hydrogen-burning starts inside it; it now produces enough temperature and pressure to counter the inward pull of gravity and thereby attain dynamic equilibrium (B)

mass of the proto star from which the star was made The more massive a star is, the greater is the gravitational pull and faster the contraction, resulting in a steep increase in temperature and pressure This triggers hydrogen-burning earlier, the more massive stars also consume hydrogen at a prodigious rate compared to low mass stars so that sufficient heat and pressure can be generated at the core to keep at bay the greater gravitational pull inwards Hence, the more massive a star is, it burns all its hydrogen resources faster, leaving the Main Sequence earlier

When the hydrogen in the core reaches the last dregs, the core is unable to produce sufficient energy to withstand the relentless pull of gravity The balance maintained between gravity and the outward pressure is finally lost in favour of gravity and the star begins to collapse As the inward movement gains momentum, the temperature and pressure at the core increase far beyond that required for hydrogen ignition, finally reaching the critical temperature of 100 million degrees when helium ignition starts The core by now, is rich in helium which is the *ash* of hydrogen burning Once helium-burning starts, enough energy is produced to halt further collapse of the star, achieving a second state of dynamic equilibrium between gravity and the core pressure The ash of helium-burning is carbon and oxygen

Simultaneously, another phenomenon is taking place in the opposite direction The core collapse that started before helium burning is so fast that the outer shell of the star, where there is still enough unused hydrogen, is literally left behind With the temperature rise in the core from helium burning, the hydrogen in the outer shell also ignites Helped by the increased energy output of the core the hydrogen burning outer shell expands outward, bloating the star a million times and making it a red giant Due to the lesser amount of hydrogen burning over a larger outer shell, the surface is cooler making the star radiate red light instead of blue or violet Hence the name red giant (Fig 2)

After another 5 billion years, this fate awaits our Sun When the Sun finally evolves into a red giant, the orbits of Mercury, Venus and the Earth will all be within the Sun All these planets will be vaporised

Meanwhile the helium-burning core of our red giant is steadily using up this secondary nuclear fuel also, and in course of time all the helium is exhausted, leaving a carbon-oxygen core Having no source of energy now to prop up the star against the inexorable pull of gravity, it starts to collapse again. This raises the temperature of the core again The

Fig. 3 The model of a black hole candidate. HDE 226868 is losing matter, which streams across to a black hole in orbit around it, producing the intense X-radiation that we see as the source Cygnus X-1

temperature rises high enough to ignite the helium shell which was left behind during the collapse at the end of helium-burning. Thus, at this stage, while the core stands depleted of all nuclear fuels, the gaseous shell of the star has an outer layer burning hydrogen and an inner layer burning helium. In the case of low mass stars like our Sun, no further nuclear reaction is possible since the mass is insufficient to sustain the collapse of a carbon-oxygen core till the temperature rises sufficiently to ignite these elements.

However, gravity keeps on shrinking the carbon oxygen core till the atoms are so closely packed that the electron shells of neighbouring atoms pressing each other cannot withstand the inward pressure of gravity any more. The atoms finally give way. The electron shells are torn asunder. In the resulting electron fluid in which electrons touch each other, the dislodged atomic nuclei float around. Just as a bucketfull of soap bubbles, when burst, occupy only a small volume in the form of soap liquid, the star when transformed to a plasma of nuclei floating in electronic fluid is crushed to the size of the Earth. At this stage, when each electron is pressing tightly against its neighbours, there is no further room for compression. This state of matter is known as "degenerate matter." (There can be further compression only if two or more electrons occupy the same state which is not possible according to the Pauli exclusion principle.) As a result, further collapse of the star is stopped. The surface temperature of the star which was around 100,000 degrees when the collapse started slowly cools to about 50,000 degrees by the time the star contracts to the size of the Earth. Even at this lower temperature, it shines with a brilliant white light due to the lesser surface area and is transformed into a white dwarf. The density of a white dwarf is so great that a spoonful of white dwarf matter will weigh 1,000 tonnes!

But white dwarfs are not the ultimate gravitational terminals. S Chandrasekhar, who won the Nobel Prize last year, showed in the early 1930s that even the pressure of degenerate electrons cannot resist gravity indefinitely. There is a limit to the mass of dying stars whose collapse can be halted by such pressure. According to his calculations, the pressure of degenerate electrons can shore up collapsing stars having upto 1.4 solar masses only. This is known as the Chandrasekhar limit. Therefore, white dwarfs must necessarily be 1.4 solar

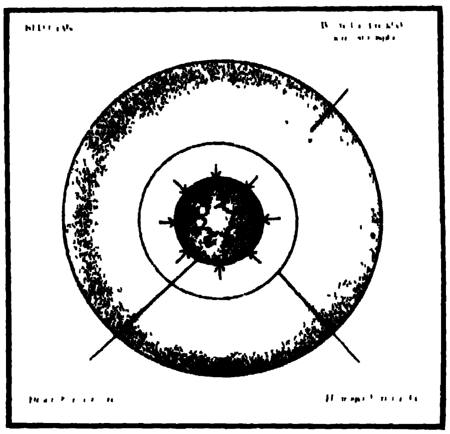


Fig. 2 The red giant- the helium-burning stage in the life of a star, surrounded by a hydrogen-burning shell

masses or less. What happens to dying stars more massive? To this question, Chandrasekhar himself had replied: "One is left speculating on other possibilities."

Possibility one: neutron stars

The Sun is but an average star among the hundreds of billions of stars in the Milky Way Galaxy. Billions of stars are more massive than the Sun, some having upto 50 solar masses! What will happen when one of these heavyweights begins to breathe its last? In the case of low mass stars, no nuclear fires beyond helium burning are possible. However, the heavies not only continue through the carbon and oxygen-burning stages, leaving silicon ash but also go through silicon-burning at 3 billion degrees temperature, creating iron. That is the last gasp of even the mightiest of stars, for iron does not burn however much the temperature rises. The conditions of temperature and pressure inside such an iron-rich star core is so extreme that the iron atoms are reduced to "degenerate matter". But unlike in a low-mass star, degeneracy pressure of electrons is no match for the brute force of this giant's gavity. As a result, electrons and protons are induced to interact forming neutrons. Since protons and electrons are present in equal numbers in the star, the result of gravity's victory over the pressure of degenerate electrons is that the entire star core is converted into neutrons. there is a sudden and violent implosion of the core, releasing energy equal to what the star had produced during its entire preceding life. This rips the whole star apart, presenting perhaps nature's most awesome spectacle—a supernova, more brilliant than a hundred million Suns. A supernova is short-lived—from a few days to a few months. The mass of what is left behind of this imploding star core can be even beyond the Chandrasekhar limit. But can it go on contracting indefinitely? No. Just as contraction of a white dwarf was stopped by the degeneracy pressure of electrons mutually in contact, the implosion of the supernova remnant is halted by "degenerate neutron pressure" of neutrons tightly sqeezed against each other. Thus our heavyweight star has reached static stability, becoming a neutron star.

As the core implodes with the release of immense energy causing the explosion, temperatures and pressures are reached in the exploding shell high enough to fuse protons and neutrons together in such numbers as to form nuclei of elements more complex than iron. The creation of all elements in the universe heavier than iron, including those in our bodies, were side-kicks of supernova explosions billions of years ago.

A neutron star of 2 solar masses will measure only 32 km across and a spoonful of its matter will weigh 40 billion tonnes! If the Earth were to be transformed into a neutron star, it will

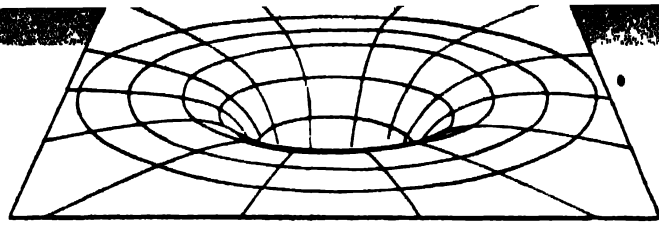


Fig. 4 The curvature of space caused by the presence of a massive object

be a sphere having the diameter of the dome of Jama Masjid! But even neutron stars are not the end of our quest Just as a white dwarf cannot be more than 1 4 solar masses, a neutron star cannot be more than 2 5 solar masses What happens to imploding star cores with more than 2 5 solar masses?

Possibility two—black holes

If what is left behind of a star after a supernova explosion is more than 2 5 solar masses, the weight of the superdense star will be so crushing that nothing in the universe can stop its total collapse, not even the strong nuclear force The collapse will continue till the entire matter of the star is crushed out of existence, leaving a black hole in space-time Nothing can come out of it, not even light To understand why, we must know two things (a) if anything is to leave a heavenly body permanently, it must be expelled from the body at a minimum velocity called its escape velocity, and (b) the velocity of light is the universal speed limit

A superdense, supermassive star with more than 2 5 solar masses, once it begins its collapse, will go beyond the neutron star stage and keep on collapsing A stage will soon be reached when the escape velocity on its surface will be equivalent to 300,000 km per second, that is, the speed of light Once the collapsing star crosses this point, not even light can escape from it No event beyond this point is observable from our universe and hence this limit is called the "event horizon" of the black hole The radius of this spherical gateway of no return is called the black hole's Schwarzschild radius, after the German astronomer, Karl Schwarzschild, who first calculated it The event horizon of a 2 5 solar mass black hole will be just 7 5 km across! And suppose the Earth were to become a black hole, its event horizon will be 0 43 centimetres! Yet, the collapse does not end there but goes on till the star shrinks to a single point called the "singularity" Since a point, mathematically, has no dimension, the star vanishes from our universe at the singularity In fact, as of now, what happens beyond the event horizon is anybody's guess

It is clear that we will never be able to observe a black hole directly But there is a fairly reliable indirect method which depends on locating companion stars to X-ray sources in the sky With the launching of the X-ray satellite *Uhuru* (meaning freedom in Swahili) in 1970, the bonanza of heavenly X-ray sources really began Many hitherto unknown X-ray sources were detected, among them a peculiar and powerful source in the constellation Cygnus, the peculiarity was that the X-ray emission was not only varying in intensity but also flickering at the fantastic rate of a thousand times every second This source, by then dubbed Cygnus X-1, was taken up for special study Soon the location of Cygnus X 1 was found to coincide with the position of a big star identified as HDE 226868 But then, according to calculations, anything which is blinking so rapidly as Cygnus X-1, could not be larger than 300 km across Therefore, the X rays must be coming from something else, but very close to HDE 226868 The possibility then arose of this star being one of a binary system Further studies confirmed that HDE 226868 was a supermassive star of about 20 solar masses with an invisible X-ray emitting companion of nearly 10 solar masses! How can a 10-solar mass star have only a diameter of 300 km? It can! But only when it is a black hole So the first black hole candidate was identified Subsequently, many likely black hole candidates have been located, mainly in the cores of galaxies and globular clusters of stars

Black holes come in all sizes, from the sub-atomic to the stellar The British astrophysicist, Stephen Hawking, has speculated on the possibility that there can be millions of mini black holes in the universe which were created at the time of the Big Bang (explosion of the primordial matter by which the universe was created, as is generally accepted) Hawking argued that at the moment of the Big Bang, portions of the exploding matter were subject to such tremendous pressure and temperature that a number of lumps of primordial matter were crushed inside their event horizons by these external forces Thus, unlike massive stars collapsing by themselves into black holes, these primordial black holes were crushed out of existence by external forces at almost the same moment of creation Such mini black holes may be lurking in nearby space

A black hole has tremendous gravitational pull, and it keeps devouring matter like a demon What happens when you approach a black hole? As you approach a black hole the gravitational tidal effect (tidal effect is the differential in the gravitational force by which the extremities of an object is attracted by another object) will keep on increasing without bound and will tear any finite sized object apart The Moon's tidal effect causes the oceans of the Earth to rise and fall as the Earth rotates The Earth's tidal effect on our bodies is so minute that it is equivalent to pulling our feet down towards the centre of the Earth with an extra weight of about 4 drops of water than the head But if we are standing on a 2 5 solar-mass black hole, the differential in the pull between the head and feet will be about 50 million tonnes!

Due to an effect of the Special Theory of Relativity known as time dilation, as future astronauts approach the event horizon of a black hole, they would appear to be moving progressively slower and slower, and at the event horizon they will stop dead Side by side, due to another effect of the General Theory of Relativity, light from the astronaut will progressively become less and less energetic in the tremendous gravitational field of the black hole and at the event horizon, he will completely fade away The astronaut himself will notice nothing of this since his body metabolism and even the movements of the atoms in his body will correspondingly slow down □

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'LOGY'CAL LEARNING

Maneesh Mohnot

IMMUNOLOGY, ecology, toxicology, sociobiology—science abounds in 'logies' But what does 'logy' signify? The suffix 'logy' is derived from the Greek word *logos* meaning 'science' or 'telling' Here we present 10 words ending in 'logy', can you logically conclude what they stand for?

Answers on pages 76 and 77

(1) Tocology:
(A) Science of childbirth
(B) Branch of political economy dealing with wealth production
(C) Speech or writing in praise of a person

(2) Deontology:
(A) Science of morality or ethics
(B) Phrase with two meanings
(C) Science of cookery

(3) Harology:
(A) Study of the art of making clocks
(B) Study of accounts of descent from ancestors
(C) Study of antiquities

(4) Entomology:
(A) Science of human varieties
(B) Study of insects
(C) Science of character

(5) Sitology:
(A) Knowledge of the Chinese language
(B) Study of cells
(C) Science of regulation of diet

(6) Demonology:
(A) Study of filthy insects
(B) Literature about devils
(C) Science of mental diseases

(7) Ornithology:
(A) Study of snakes
(B) Science of ear diseases
(C) Science of birds

(8) Pathology:
(A) False reasoning
(B) Study of diseases
(C) Universal knowledge

(9) Penology:
(A) Study of muscles
(B) Study of prison management
(C) Study of fermentation

(10) Neurology
(A) Science of astronomy
(B) Study of the brain and nervous system
(C) Study of defective pronunciation

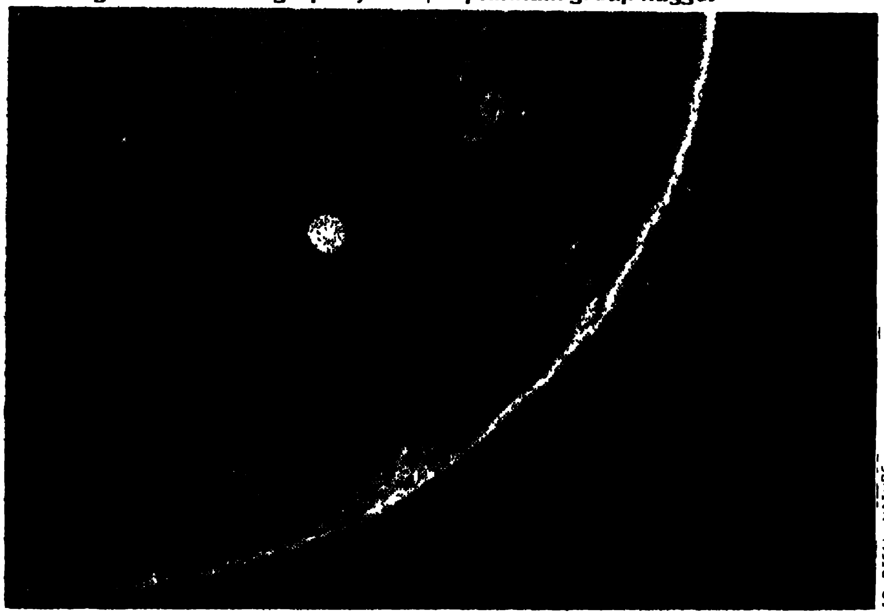
NUGGETS FROM SPACE

THE interplanetary space through which the Earth and the Moon circle the Sun contains a wide variety of objects representing perhaps the left overs from the time of the formation of our solar system These objects are of sizes ranging from specs of dust to major meteorites, asteroids or comets The larger their size, the smaller is their number and less the chances of their hitting the Earth It is estimated that the mean collision time for an asteroid of 10km diameter hitting the Earth is about 100 million years

In contrast, about 100 million meteors of much smaller size enter the atmosphere daily with velocities up to about 100 km per second but are usually destroyed before they reach the Earth Many medium size meteors survive the fiery passage through the atmosphere and reach the surface of the Earth becoming meteorites Fragments varying in weight from a few kilos to hundreds of kilos have been recovered An intensive study of these remnants helped scientists to unravel some of the mysteries of the creation of the solar system the Earth and its geological and biological evolution The meteorites are broadly classified into irons, stony irons, chondrites and achondrites The chondrites are characterised by the presence of spheroidal aggregates of about one millimeter diameter, known as chondrules The irons consist essentially of a nickel iron alloy with four to 20 per cent nickel

There are some important aspects of the mineralogy of the meteorites which distinguish them from terrestrial matter Nickel iron alloy is practically absent from terrestrial rocks The meteoritic material has a relatively higher abundance of platinum metals —osmium, iridium, ruthenium, platinum, rhodium and palladium The core of the Earth essentially consists of iron-nickel and the platinum metals have migrated to this zone Some of these features help the investigator distinguish terrestrial from extra terrestrial material

Scanning electron micrograph of an 8-μm platinum group nugget



COURTESY NATURE

Cosmic spherules

In 1876, Sir John Murray published observations on magnetic spherules extracted from deep-sea sediments collected by the *Challenger* expedition The rather unexpected occurrence of elemental metals in the spherules led him to attribute extra terrestrial origin to them Pettersson and Fredriksson collected by a magnetic concentration process, 'hundreds' to 'thousands' of spherules per kilo of sediment samples from the Swedish expedition with the *Albatross* These authors calculated the quantity of spherules reaching the Earth's surface to be of the order of 2,500 to 5,000 tons annually Many of the spherules examined by them showed a metallic nucleus inside a layer of iron oxide

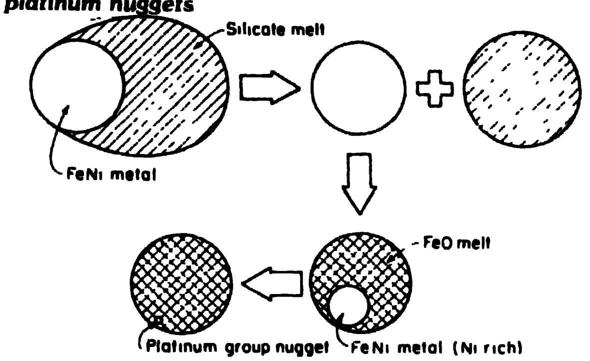
Smales, Mapper and Wood (*Geochim Cosmochimica Acta*, 1958) applied the sensitive radioactivation analysis to some of these samples and determined the nickel/copper, nickel/cobalt, copper/cobalt and nickel/iron ratios, compared the values with those obtained for iron meteorites and concluded that the spherules are of cosmic origin Casting and Fredriksson (*Geochim Cosmochimica Acta*, 1958) using an X-ray microanalyser technique showed that the metallic nucleus of the spherule contained 30 per cent nickel, 69 per cent iron and 1 5 per cent cobalt while the iron oxide shell showed less than 0 5 per cent nickel They propounded that the spherules were formed during the flight through the atmosphere, where they attain high temperatures for a very short time During this stage, while the oxide layer is formed, nickel concentrates in the metallic nucleus Many claims of isolations of air borne spherules proved to be of either volcanic or industrial origin However, the existence of authentic extra-terrestrial spherules in sedimentary deposits is well established now

Platinum group nuggets in deep-sea sediments

Though the greater abundance of platinum group metals (PGM) in meteoritic material compared to terrestrial rocks is known for quite some time, no one observed them in any concentration above a few parts per million In a recent paper (*Nature*, June 1984) Brownlee, Bates and Wheerlock reported the occurrence of nuggets of PGM of five to ten microns in iron oxide spheres, 300 to 500 micron diameter, collected from the ocean floor These spheres do not contain an iron-nickel metal core but are almost entirely made up of magnetite and wustite, a metastable iron oxide which is present only in material of meteoritic origin These authors established that more than 70 per cent of the mass of a typical nugget is composed of an exotic alloy containing Os, Ir, Ru, Pt, Rh and Pd From the known abundance of PGM in cosmic material they concluded that practically all the PGM contained in the meteoritic sphere is very efficiently concentrated in the nugget

The sequence of events that lead to the formation of the nuggets is outlined as follows An interplanetary dust particle melts (stage-1) during the atmospheric entry and forms the composite spheroid of molten silicate and metal Due to density difference the two parts separate (stage-2) As the metal sphere develops a rapidly growing oxide shell, elements more 'noble' than iron concentrate in the shrinking metal core (stage-3) When oxidation is nearly complete most of the iron and nickel

The most common sequence of events that produces iron cosmic spheres containing platinum nuggets



leave the core resulting in a small nugget of nearly pure PGM (stage-4). By a simple calculation Brownlee, Bates and Wheerlock predicted that the iron cosmic spheres that formed before the abundance of oxygen in the atmosphere reached half its present level could not be totally oxidised during entry and should not contain PGM nuggets. If dated stratigraphic layers of the ancient sediments are re-investigated for cosmic spherules and the existence of PGM nuggets established, it should provide an indication as to when the oxygen abundance in the Earth's atmosphere reached half its present level.

Oxygen and evolution

Berkner and Marshall discussed the role of the Earth's atmosphere in the evolution of life on Earth. According to them, evolution during any geological period must be interpreted as a complex interaction between the oxygen level in the atmosphere and the way in which that level produces opportunities for evolution. According to them, major evolutionary outbursts occurred when oxygen reached a level of one per cent (Paleozoic era, 600 million years ago), and 10 per cent (late Silurian 400 million years ago) of the present value. They even suggested that for the past 300 million years both oxygen and carbon dioxide may have fluctuated about the present levels in a series of saw toothed oscillations, dropping suddenly perhaps to the 10 per cent level, and again rebuilding slowly.

PGM nuggets and evolution

A search for cosmic spherules and PGM nuggets in ocean sediments of different ages might give evidence for the oscillating oxygen levels in Earth's atmosphere passing through the 50 per cent (of present value) level and help solving some of the puzzles of evolution.

Alvarez, Alvarez and Asaro (*Science*, 1980) explained the great extinction of several living species about 65 million years ago (Cretaceous Tertiary, C T, boundary) by postulating an asteroid (about 10 km diameter) strike, the resulting dust cloud spreading over the globe, hiding the Sun for years, suppressing the process of photosynthesis with the ultimate extinction of several species. They substantiated the argument citing a sharp increase (30 to 150 fold) in the abundance of iridium in the one cm thick clay layer that marks the C-T boundary in the Apanines of northern peninsular Italy and the sea cliff of Stevens Klint, about 80 km south of Copenhagen.

Thus the PGM in the extraterrestrial material that reaches the Earth and gets deposited in the undisturbed sedimentary layers of the ocean may throw light on several terrestrial events of the past epochs. Meanwhile it is an idle but tempting speculation whether PGM nuggets can ever form an economic source for these precious metals on the globe.

T.K.S. Murthy

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HEPATITIS VACCINE SOON?

HEPATITIS B virus (HBV) infection constitutes one of the major causes for hepatitis a liver disease that is prevalent throughout the world. In many Asian and African countries HBV related hepatoma is the most common malignant tumour, accounting for about 30 per cent of all cancer deaths among males. The need for an effective vaccine is thus obvious.

A new vaccine has already been developed. This is an important landmark in the history of preventive medicine. This vaccine is prepared from the surface antigen of HBV, known as Hepatitis B surface antigen (HBs Ag) present in the serum of persons chronically infected with HBV. Although this vaccine is proved to be safe and effective, its high cost and limited availability precludes its use for the poor section of the world for whom hepatitis constitutes a major health problem. Other ways of preparing effective and specific vaccines for HBV are under investigation. They are a) Recombinant DNA technique, wherein appropriate DNA fragments derived from HBV can be incorporated into a suitable vector and b) synthesis of long, chain peptides having the same amino acid sequence as that of the protein of HBs Ag.

R C Kennedy, J L Melnick and G R Dressman of Baylor College of Medicine, Texas, USA, have now introduced a new concept in the preparation of a vaccine against HBV through idiotype-anti-idiotype antibody network (*Science*, **233** 1984). Idiotype is an antigenic determinant near the antigen binding site of an antibody. These scientists have characterised an idiotype common to human antibody and BALB/C mice antibody to HBsAg (inter species idiotypic cross reaction) and they prepared an antibody to this idiotype (anti-idiotype antibody can recognise a common idiotype associated with the antibody to HBsAg.

It has been found by the authors that the prior injection of an anti-idiotype antibody into mice enhances immunoglobulin M (IgM) anti HBsAg, when the mice were immunised with HBsAg. They could now induce antibody to HBsAg in mice by injecting them with anti-idiotype antibody alone. In an actual experiment, a group of six mice were injected with affinity-purified rabbit anti-idiotype antibody absorbed in alumina gel (alumina gel is used as an adjuvant). A control group of mice were injected in a similar way but with immunoglobulin G (IgG) from rabbits prior to immunisation. The antibody titre of the sera obtained from the mice were determined by the solid phase radioimmunoassay technique.

The authors found the presence of the antibody to HBsAg in high titre in all six mice of the first group. But no findings suggest that an anti idiotype antibody may be useful as a vaccine. Also the anti-idiotype antibody produced in other species may not be suitable for human use. However, this problem as suggested by the authors, can be circumvented by human monoclonal antibodies. Let us hope that hybridoma-produced anti-idiotype monoclonal antibody will provide an effective, safe and inexpensive vaccine against HBV.

N. Sivaprasad

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The White Hole Universe

John Gribbin

Einstein's theories work equally well when applied to the Universe at large. From the first split second of an exploding fireball to the far future, billions of years from now, the Universe can be pictured as an inside out black hole

Einstein's equations—the equations of general relativity—describe the behaviour of spacetime in the presence of mass-energy. The Universe we live in is a region of spacetime containing mass-energy, and it is no surprise to learn that Einstein's equations can be used to describe the behaviour of the Universe. Strictly speaking, though, Einstein's equations can *only* be used to describe the behaviour of a complete Universe. When we use them to describe the behaviour of light passing near the Sun, or the orbit of Mercury, we are actually using an approximation, because general relativity is a complete theory dealing with complete regions of spacetime, which means the whole Universe. The equations can happily be applied to black holes, which are Universe miniature regions of space time bent around and cut off from the almost flat spacetime that stretches across the visible Universe, and they can equally happily be applied to the puzzle of how our Universe came into existence, and how it evolved into the state we see today.

That is the puzzle that Einstein set out to solve with his theory of gravity and spacetime. But his first attempts to solve the puzzle produced answers as baffling as the original puzzle. The equations that had proved so dramatically successful in solving problems like the bending of light near the Sun, or the detailed nature of the orbit of Mercury, seemed to be less successful when they were applied to the whole Universe, a complete region of spacetime which they had been designed to deal with. The paradox stemmed from a misunderstanding about the nature of the Universe which Einstein shared with every astronomer in the early part of the twentieth century.

When we look up at the night sky, we see a picture of stability. Seasons come and go, with changing patterns of stars, but apart from this regular rhythm, the stars seem unchanging and constant of any human time scale. So astronomers assumed that unchanging constancy was a key feature of the Universe at large. At the beginning of the twentieth century, stars were all that astronomers knew of the Universe and what we now think of as our Milky Way Galaxy, an island of thousands of millions of stars like our Sun, set in an almost empty sea of spacetime dotted with other island galaxies and clusters of galaxies, was all the Universe to them. So Einstein's first attempts to describe the structure of the Universe using the equations of general relativity were aimed at producing a picture of stability, a Universe of flat spacetime which stayed the same on average, forever. The equations he had set up, however, stubbornly refused to play ball. Analyze them as he might, Einstein found that in their original form they could not be made to describe such a static Universe. He could get mathematical models, as we would now call them, that described regions of spacetime collapsing upon themselves under the influence of gravity (black holes), and he could get mathematical models of Universe bursting outward from a singularity, like a black hole in reverse (remember the equations are time symmetric). But he couldn't get mathematical models which produced a Universe balanced on the knife edge between expansion and collapse.

Of course, there were variations on the theme. Some of the expanding model universes slow down and reverse their expansion, collapsing back in upon themselves. And it is possible to build a mathematical description of a Universe, consistent with Einstein's equations, which starts at infinite size, collapses down to a finite state (but not a singularity), then turns around and expands back out to infinity. Einstein even managed to find a way to fiddle a stable Universe out of the equations, but only by adding an extra constant, a new parameter which had no roots in the study of gravity which had given Einstein the basis for his cosmological calculations. In later years, Einstein described this fiddle as the biggest mistake he ever made, and although theorists still dabble with models involving cosmic constants we, like Einstein in later life, can ignore such ideas. For, by the end of the 1920s, it had become clear that our Milky Way does not represent all of spacetime, and that our Universe is not delicately balanced between the alternatives offered by general relativity in its simplest form, expansion or collapse. Thanks to the pioneering work of Edwin Hubble, astronomers knew by then that the Universe contained many galaxies more or less like our Milky Way system (we now know there are thousands of millions of such islands in space), and that by and large they appeared to be rushing apart from one another. In other words, the Universe we live in is expanding, as Einstein's equations had tried to predict, and as Einstein himself refused to believe until the observational evidence came in.

The expanding Universe

This is something that cannot be stressed too highly. Ask any cosmologist today, and he will tell you that the single most fundamental fact we know about the Universe is that it expands. Hubble's discovery of the expanding Universe came

as a surprise to everybody in the 1920s Yet Einstein's equations had predicted the discovery, whether Einstein liked it or not The single most important thing we know about the Universe we live in was predicted by general relativity powerful evidence indeed that general relativity provides a good description of the Universe

How do we know that the Universe is expanding? Without going into the details of Hubble's epochal discovery,* the essential point is that distant galaxies show a red shift in the light we receive from them The light from any object, such as a star or a galaxy (which is a collection of stars) can be split into its component colors, the spectrum of the rainbow, and such a spectrum is marked by dark or bright lines which are as characteristic as fingerprints and show which elements—which atoms—are present in the hot object which is radiating the light The optical spectrum, the band of light visible to our eyes, runs from red to blue, with red light having longer wavelengths and blue light shorter The light from stars in our own Galaxy show many spectral fingerprints of different elements, and the light from distant galaxies shows the same fingerprint patterns, but shifted toward the red and away from the blue end of the spectrum In other words, the wavelength of the light from distant galaxies has been increased, stretched somehow compared with light from objects in our own Galaxy The simplest explanation of this is that the distant galaxies are moving away from us, and from each other This has the effect of stretching the wavelength of light from those galaxies, in the same way that the note of a passing police car siren is deepened as the car speeds away from us

A battery of astronomical tests shows that for the galaxies near enough for their distances to be estimated by other means, the red shift in their light is proportional to their distance from us This is exactly consistent with the simplest models of general relativity, and very few astronomers now doubt that all galaxies obey the same red shift/distance relation, dubbed Hubble's law in honour of its discoverer The more distant a galaxy is from us the faster it is rushing away, and the distance to any galaxy can be determined by measuring its red shift This is the inheritance Hubble gave to astronomy, and it provides the observational evidence which backs up the reality of the simplest cosmological models of general relativity

Einstein's equations describe, in their simplest form, a Universe in which everything is receding from everything else, just as Hubble's observations show We are not at the centre of the Universe with everything receding from us—spacetime itself is expanding, carrying along the islands of mass energy (galaxies) with it, so that everywhere in the Universe we would get the same picture of galaxies receding from us in line with Hubble's law Imagine an infinitely large plum pudding, with no centre, expanding in the same way that the Universe expands From the viewpoint of every plum in the pudding every other plum would be receding, but none of the plums is moving through the pudding, just as, apart from minor local motions, none of the clusters of galaxies in the Universe is moving through the fabric of spacetime It is spacetime that expands, carrying us along for the ride

Still, few of us are really comfortable with the idea of "empty space" being elastic, and able to stretch, squeeze, or bend It is more comfortable to think of the galaxies, or clusters of galaxies, rushing apart like the fragments of an explosion Up to a point, the analogy is useful But remember, it is only an analogy, as we use it to wind our picutre of the Universe back to the beginning, the Big Bang

If all the galaxy clusters are rushing apart, then the Universe must have been in a more compact, denser state in the past with galaxy clusters closer together than they are now Push this to extremes, and we envisage a time, long ago, when all the galaxies were touching, before that, the Universe must have been a very different place, and if we keep pushing back in our imagination we come to a time when all the stars of all the galaxies were dissolved in a primeval superstar, a fireball—the big Bang in which the Universe as we know it was born So much we might have guessed from Hubble's observations of the expanding Universe, even without the aid of Einstein's equations The beauty of general relativity, and the serendipity of its development at the same time as observers were building new telescopes and discovering the true nature of the Universe, is that it describes in great detail just how such a cosmic fireball expands from near a singularity, out of a region of almost infinite density and almost infinite temperature

Although very few cosmologists, if any, would use the term to describe the Big Bang, it is exactly what I mean by a white hole—a black hole in reverse We live in a white hole Universe, and the more people are familiar with the concept of black holes in the Universe the more helpful the image of a white hole Universe is What it really is, though, is Einstein's Universe, the simplest model Universe described by general relativity is indistinguishable from the Universe we see about us We cannot use Einstein's equations, or any others, to describe what happens at singularities or infinities, which is why I say that we can picture the expansion of the Universe from a state of *almost* infinite temperature and density, close to the singularity in which, it seems, everything was created But we can now get very close indeed to that singularity To be precise, theorists now think they can get back to the first 10^{-35} of a second after the outburst from the singularity And the conditions their equations describe there are not that different from the world of particle creation and exploding black holes described by Stephen Hawking in recent years

The cosmic fireball

In the extreme conditions of the primeval cosmic fireball, particle creation was much less of a trick than it is even in the region of bent spacetime near a black hole What matters when it comes to making particles is the energy density of the radiation around, and with almost infinite energy density it is possible to create particle antiparticle pairs with very large masses Of course, they don't "live" very long, like the virtual particles of "empty space" today, each particle soon meets up with its antiparticle counterpart and disappears in a puff of energy But as the Universe expanded, it thinned out, which is another way of saying that the energy density and temperature decreased Today, matter and radiation are still the two most important components of the Universe, but the thinning out process has gone so far that the density of the remaining background radiation is too low to make any real particles, and only the bubbling spacetime of virtual particle-production remains as a theoretical reminder (and a practical one near black holes) of how the Universe began The surprise, to theorists first grappling with all the implications of Einstein's equations in the thirty years after the realisation that the Universe really is expanding, was that any matter is left over at all In the fireball days, energy radiation dominated the mass-energy duality, and material particles were four ephemeral visitors to the fabric of spacetime If every pair then meets and annihilates itself, how there was any matter

The laws of physics that govern the conversion of energy to material particles may not be perfectly symmetrical. Do we owe our existence to an imperfection in these laws?

point when the Universe thinned out cooled down - to the point where particles could no longer be created from the background radiation?

Various ideas have been offered Perhaps the Universe really contains equal amounts of matter and antimatter, but somehow the two got separated long ago Maybe some of those galaxies we see flying away from us in the expanding Universe are actually made of antimatter But in recent years an alternative suggestion has gained favour It now seems that the laws of physics which govern the conversion of energy into material particles are not perfectly symmetrical, after all A tiny asymmetry in the equations leaves scope for a tiny fraction more particles to be created than antiparticles After the fireball era of the Universe, when all the antiparticles had met their particle partners and annihilated themselves, turning back into energy, a few particles were left over These, the afterthought of creation, now form all the stars (and their planets) in all the visible galaxies We owe our existence, it seems, to an imperfection in the laws of physics

What happened to all the radiation? It's still there, and it still fills the whole of the Universe But the Universe has expanded so much since the Big Bang that what was once a radiant fireball of heat energy is now a weak hiss of radio noise, with a temperature equivalent to just under 3 K This is the black body background radiation, the discovery of which earned Arno Penzias and Robert Wilson a share of the Noble prize, and provided yet another observational proof of the validity of the Big Bang theory With modern radio telescopes, astronomers can eavesdrop on the echo of the Big Bang itself, and by taking the temperature of this radiation today and working backward in time, they get another handle on the temperature the Universe must have had when it was young and dense We learn from the background radiation what the Universe was like the last time matter and radiation interacted, which occured just before it cooled to the point where electrons and protons became bound together as atoms

Electromagnetic radiation only interacts with charged particles, so the last "scattering" of the background radiation occured when the last negative electrons and positive protons were being bound together in electrically neutral atoms The temperature at which this happens is about the same as the temperature at the surface of the Sun today, some 6,000 K, the Universe reached that temperature about 100,000 years after the Big Bang -- at that time, the whole Universe was like the surface of our Sun Studies of the background radiation today show that it is very uniform, coming from all directions in space equally strongly, except for effects which can be explained in terms of the local movement of our Sun and Galaxy through spacetime This tells us that the Universe itself was very uniform 100,000 years after it was born, with electrically charged particles spread evenly through out it And this in turn tells us that the simplest cosmological models of general relativity, the Big Bang models which described uniform expansion of uniform universes, are indeed the best guide to how the Universe got from the Big Bang to the state, 100,000 years later, where matter and radiation finally decoupled and went their separate ways For comparison, various estimates based on measurements of the rate at which galaxies recede from one another, and tests involving the radioactivity of samples from meteorites, show that the Universe has now been in existence for something between 10 and 20 billion years, with most tests favouring the lower end of this range And our Sun and Solar System have existed for nearly 5 billion years, probably about one third of the life of the Universe to date

Back to the beginning

In order to keep some sort of a link with the Universe as it is today, we can continue our imaginary probe back toward the Big Bang itself from those last days of the fireball when matter and energy decoupled Remember that, the Universe grew from the Big Bang outward, but that we are looking at the time reversed pattern, a black hole instead of a white hole This may, however, be of more than passing relevance to the Universe itself, as we shall see

Going back in time earlier than 100,000 years after the Big Bang, the Universe simply gets hotter and denser, with no significant change in its other properties, until we are within a few minutes of degrees, and before then it was too hot for protons and neutrons to exist in stable atomic nuclei From the first few minutes onward, the particles that came out of the earlier phase of the Big Bang were arranging themselves into atomic nuclei, 75 per cent hydrogen and 25 per cent helium, as we learn from studies of the composition of old stars, revealed by the fingerprint lines in their spectra After 100,000 years, as we have seen electrons became bound to the nuclei The epoch since then has been the epoch of atomic matter, and the interval from a few minutes to 100,000 years was the epoch of nuclear matter The first three or four minutes of the Big Bang, however, mark the epoch when the relevant physical laws were those particles they conjure up in energetic interactions in their particle accelerators, smashing protons into each other, or into atomic nuclei, to see what comes out

At this stage, simplicity is all We see the Universe to be a very simple place, expanding uniformly and the same every where The undoctored equations of general relativity describe just such an expanding Universe, hinting at underlying symmetry and simplicity Back in the first few minutes, our theories are operating under conditions where they cannot be tested in the Universe today, and all we can do is follow the simplest path But the simplest path leads to a clear, consistent picture which is certainly speculative, in that it can never really be tested, but seems to provide a working description of the birth of the Universe

Pushing back into the particle epoch, we make the simple assumption that the Universe keeps getting hotter as it squeezes more densely together--as spacetime shrinks At an age of 10^{-5} (0 00001 seconds), individual protons and neutrons are packed together side by side, like the particles in a neutrons star, and our everyday experience of the behaviour of matter begins to break down What happens when the particles are squeezed even tighter together? One suggestion is that they dissolve into a "quark soup," quarks being the hypothetical particles invoked to explain the events particle physicists see in their experiments One of the best current theories says that ordinary particles such as protons and neutrons are themselves made of quarks * But as we try to probe further back towards the singularity, even the concept of particles becomes a little fuzzy at the edges

Remember the uncertainty of quantum mechanics Each particle exists in a fuzzy state, spread over a small volume of spacetime, and there is a strong conviction among relativists that the real breaking point of general relativity comes where quantum effects dominate Relativity is a

* And, sure enough, some theorists suggest that quarks may lie in the hearts of neutron stars, where the neutrons themselves have been crushed out of existence

NEW SCIENTIST

"classical" theory in the sense that it deals with particles in the same basic way as Newton did, treating them as well determined objects with precisely identifiable locations and velocities General relativity cannot happily deal with fuzzy, uncertain objects, and back around 10^{-43} seconds after the Big Bang the Universe was so small that the quantum mechanical size of the individual quarks was significant -the time left between then and the singularity is so small that the particles can't be sure whether they are one side of the singularity or the other This provides clues, perhaps, to the nature of the Big Bang itself ** At present, though, we have no description of gravity that includes quantum mechanics, and without such a theory we cannot get closer to the Big Bang than 10^{-43} seconds That, however, is close enough to be impressive -the ultimate spacewarp, with quarks packed as closely as quantum uncertainty will allow, and a temperature around 10^{32} K

The mass of each $\bar{X}$ particle is 10^{15} GeV, one thousand trillion times the mass of the proton, which is just 1 GeV Since the mass of a particle which can be produced out of a radiation field depends on the temperature of the radiation (a measure of its energy density), such exotic particles can only appear in the early phases of the Big Bang Close to the singularity itself, temperatures of 10^{32} K allow the creation of particles with masses up to 10^{19} GeV, 10,000 times more massive than the X particles, but once the temperature falls below 10^{28} K, at a time just 10^{-35} seconds after the singularity no more X-particles can be made, and those left over from the earlier phase soon decay into a shower of baryons (or antibaryon quarks) The asymmetry in the Universe which has left a trace of matter around today just one baryon for every billion photons was frozen into the expanding Universe at that point, 10^{-35} seconds after the Big Bang at a temperature of 10^{28} K

** It also means, as many theorists have pointed out, that we cannot say what ultimately happens to matter involved in a black hole-collapse The laws of physics we know break down at the singularity Does the collapsing matter "tunnel through" the singularity and burst out some where else? Does quantum gravity halt, or even reverse, the collapse? Those are the questions which remain to be answered, and provide some of the most exciting challenges for mathematical physicists today Be sure you haven't heard the last of black holes

To recap, in the first instant of creation, the tiniest split second, very heavy X particles were created out of the enormously dense radiation field A tiny split second later, the energy density was already too low for any more such massive particles to be created, and within a further billionth of a billionth of a billionth of a second the X-particles decayed, fragmenting into other particles and antiparticles In the shower of particles created in this way, there were just a few more of the kind of quarks that make baryons than those that make antibaryons, and the result is that in the Universe today, although there is much more radiation than matter, there remains a trace of matter, just one baryon for every billion photons, sufficient to produce all the stars in all the galaxies, and all the atoms in our own bodies

As yet, the theories are too imprecise to predict a definite number for the resulting ratio of baryons to photons, but the estimates range from 10^{-3} to 10^{-11} This is a very big range, but there is some comfort to be drawn from the fact that the actual baryon/photon ratio, 10^{-9}, does at least lie within it Lindley also points out, though, that there is another way to make the baryons, using primordial black holes

If very small, very dense black holes were present in the superdense state of the Universe, they could themselves provide the original X particles from which our present day baryons are descended, thanks to an extreme form of the Hawking process by which black holes emit particles The most extreme versions of such models of the Universe even have a "cold" origin – a cold Big Bang with the black holes doing all the work of particle production The hot model is simplest, and therefore preferable until there is some good reason to discard it, but it is nice to know that there is yet another link between the theory of black holes and the theory of the origin of the Universe Maybe the whole Universe is better described as an exploding black hole, rather than an expanding white hole But this is as far as reasonable speculation can take of the Big Bang, and the source of all the material around us, and within us We have a rough idea perhaps not so very rough – of how things got to be the way they are * The obvious question that follows is where things are going- what is the ultimate fate of the Universe? And this depends very much on the way in which space time is curved □

* But we don't know why things started out in a Big Bang Some questions are outside the domain of physics and in correspondence with me on this point Graham Blackbourn of the University of Strathclyde made an analogy between the Big Bang and a study of a game of pool Watching the balls move across the table, any competent physicist could work out which ball had been struck by the cue, how hard, and in what direction, in order to explain the various bumpings and bangings going on on the table But "this tells us nothing of how the balls and table got there in the first place, why the table top is blue and the balls of different colors, and who (?) is holding the cue!" Physics doesn't attempt to answer these questions, but they are still there to puzzle us

*Excerpted from Spacewarps by John Gribbin Penguin Books (1983) * 3.95 Distributed in India by Penguin Overseas Ltd*

ROOTS OF GENIUS

HE KNEW that he had only 24 hours left to live. At 21 years old, what could he leave behind for people to remember him by? As a person who had strong beliefs—Evariste Galois had no doubts. He isolated himself and wrote on the theme closest to his heart—higher algebra. He wrote out what is now known as Group Theory—an algebraic innovation which permeates all fields of mathematics and is now one of the most important branches of algebra.

Evariste Galois was born on October 25, 1811, at Bourg la Reine near Paris. Though he entered school at the age of twelve, by his nineteenth year, he had produced original works on the theory of imaginaries (now called 'Galois imaginaries' which are of great importance in algebra), the theory of algebraic equations and the algebraic treatment of elliptic functions. He is the creator of one of the most beautiful branches of mathematics called 'Group Theory'. It finds applications in physics, chemistry, biology and the social sciences.

But the life of this great mathematician was very sad—plagued by mental agony, disappointment, dejection and tyranny. Lack of encouragement did not deter young Galois from contributing his might to the world of mathematics until the night before his death.

"Although there is no record of any mathematical talent on either side of Galois's family—parents or forefathers, his own mathematical genius came like an explosion at early adolescence" says E.T. Bell in *Men of Mathematics*.

The college Royal de Louis-le-Grand in Paris, which Galois entered in 1823, was like a prison. It was the time of the French Revolution. Galois's mother, Adelaide Marie Demante, belonged to a family of distinguished jurists. She tutored him until the age of twelve and he was an eager student, but what disgusted him was that he was forced to learn literature, classics, Latin and Greek as major subjects and mathematics as a minor subject. Young Galois decided to pursue his interest in mathematics on his own.

He started with Legendre's geometry. At the age of thirteen he not only read the book from cover to cover but mastered it too within a couple of weeks. Boys of his age normally took two years to do the same. The boy then went on to the algebra of the greatest master of his time, namely Lagrange and thereafter to Abel. (Lagrange was called "the lofty pyramid of the mathematical sciences" by no less a person than Napoleon Bonaparte and Abel was said to have left mathematicians sufficient material to keep them busy for at least 500 years.)

Galois had the habit of solving even complicated problems entirely in his head, writing down only minimum details. This habit went against passing examinations. In the beginning, his teachers described him as very gentle and innocent but agreed that there was something strange about him. Later on, all the teachers declared in one voice that "Galois is beyond salvation, conceited, has an insufferable affectation of originality". They advised his parents to admit him to a school where he would be taught only mathematics.

At the age of sixteen Galois was already treading the path of mathematical discovery. Both he and Sadi Carnot (the father of thermodynamics) were refused admission to the Ecole Polytechnique, which was the best centre for mathematics in the world at that time. The official reason being that he failed in the entrance examination. This happened because there was no one to recognise his mathematical ability. Other sources suggest that he was refused admission on political grounds.

SOLVING BY DEGREES

TO APPRECIATE the relevance of Galois's work, it is necessary to understand the background against which it was made. Though algebra was known since antiquity, till Galois's day, mathematicians used explicit formulas for the solution of equations. The solution of the second degree or quadratic equation goes back to ancient times. During the Renaissance, the third degree (cubic) and second degree (quartic) equations were discovered by Niccolo Tartaglia and Ludvico Ferrari respectively. In 1545, Gerolamo Cardano, an Italian physician, published formulae for their solution, but the fifth degree (quintic) and higher order equations defeated mathematicians of the 17th and 18th centuries. Until the time of Paolo Ruffini, an Italian, and Neils Henrik Abel, a Norwegian. They were responsible for the Abel-Ruffini theorem. It states that the general algebraic equation of degrees higher than four cannot be solved by radicals.

Galois was independently working on similar lines and was unaware of Abel's work at the time. This was fortunate because Galois then a mere 16-year-old had already launched himself on a much more ambitious project. He sought by what is now called the Galois or Group Theory, a deeper understanding of the criteria an equation must fulfil if it is to be solvable by radicals. His method was to analyse the 'admissible' permutations (a change in an ordered arrangement) of the roots of the equation. The set of "admissible" permutations is called the Galois root of the equation. It measures what might be called the algebraic symmetries that the roots possess. In today's terminology, Galois formed the "group" of automorphisms (a particular kind of transformation) of the "field" obtained by adjoining the roots of the equation. This "group" is known as the Galois group. The "field" referred to is an algebraic system now known as the Galois or root field. Galois's ingenious discovery was that an equation of the fifth or higher degree is solvable by radicals if and only if the group of automorphisms can be broken down into prime-order constituents (prime numbers are positive numbers greater than one, divisible only by themselves and one) that always have an easily understood structure. His work came to be called the Galois Theory, which essentially is the study of the Galois fields and the Galois group corresponding to the polynomial. He perceived that solving quintic and higher order equations required an approach wholly different from that required for the quadratic, cubic and quartic.

On the eve of his death, Galois tabulated his work in the form of a letter to his friend Auguste Chevalier. His distracted notes bore hints that he had begun to develop the theory of algebraic functions, the full development of which was achieved 40 years later by the German mathematician Bernhard Riemann.

Gillian Valladares

At the age of sixteen, Galois was already treading the path of mathematical discovery. Lack of encouragement did not deter him from contributing his mite to the world of mathematics, till his death at 21

The following year was a notable one in the life of Galois He met Louis Paul Richard, a teacher of advanced mathematics, who understood the boy's mathematical prowess With Richard's help he was able to publish his first paper on 'continued fractions' in 1829 During the same year Cauchy (a great name in the mathematical world) took notice of this paper With the hope of getting recognition, Galois sent all his original works to Cauchy for submission to the Academy of Sciences Unfortunately for him, Cauchy promised to submit the papers but actually forgot to do so This was the biggest disaster that overtook the mathematical prodigy who began developing a hatred towards all academicians and the entire society in which he was forced to live He began to develop an interest in politics and began opposing the policies of the government

Galois made a second and final attempt to enter the Polytechnique but this also proved abortive He joined the Ecole Normale Superieure (as a teacher candidate) instead, at the age of nineteen but his only interest was mathematics He started working on his own and prepared three papers on algebraic equations and submitted them to the Academy of Sciences This time his papers were misplaced by Jean Baptiste Fourier and lost In a third and last attempt to gain recognition he submitted a collection of papers on the general solution of equations (now called the Galois Theory) to the Academy Simeon Denis Poisson, a great physicist and an applied mathematician, was asked to be the referee He rejected the papers saying that they were "incomprehensible" (the papers were actually too abstract and advanced for Poisson to comprehend)

Having lost all hopes of encouragement, a completely dejected Galois decided to devote all his time to politics as a young 'revolutionary' He was considered 'dangerous' by the rulers and expelled from his school Ecole Normale Superieure He was also arrested several times While in prison his passion for mathematical discovery came to the fore again He worked out some more results on the theory of equations

On May 31, 1832, when he was 21 years old, he was challenged to a duel The circumstances that led to his death were never fully explained

The duel took place as scheduled and the result was as expected Young Galois was shot in the intestine He died next morning in a hospital His manuscripts were published in 1846, but his Group Theory will keep mathematicians busy for years to come

S Sundararaj

S Sundararaj is a freelance science writer

Prof. Yash Pal, Secretary, DST

PROFESSOR Yash Pal has been appointed the Secretary, Department of Science and Technology, Government of India Earlier, he was the chief consultant to the Planning Commission He was also Director, Space Applications Centre, Ahmedabad (1973-81), Professor at the Tata Institute of Fundamental Research, Bombay, and Secretary-General, UNISPACE 82

Prof Yash Pal is well known for his contributions in the field of cosmic radiation The steady state cosmic ray propagation model, also known as the 'leaky box model' is due to him His contributions to high-energy physics are very significant

Prof. U.R. Rao, Chairman, Space Commission

PROFESSOR U R Rao, Director of the Indian Space Research Organisation (ISRO) Satellite Centre, Bangalore, has been appointed Chairman of the Space Commission

Prof Rao is one of the leading space scientists in the world He has been responsible for the development of satellite technology in India and led the team which has been responsible for the development and launching of six satellites including Aryabhata, APPLE, Bhaskara and the Rohini series of satellites

His research using ground based cosmic ray experiments and later with the pioneer series of deep space probes and explorer satellites have contributed significantly to the understanding of interplanetary physics and solar flare phenomena

He initiated and carried out X-ray astronomy experiments which have

provided a new insight into the physical mechanism of X-ray production in X ray stars

Meghnad Saha Medal

Dr Raja Ramanna, Chairman of the Atomic Energy Commission and Secretary in the Department of Atomic Energy has been awarded the Meghnad Saha Medal for 1984 by the Indian National Science Academy (INSA) for his contributions in the field of nuclear physics

The INSA has also announced that the Golden Jubilee Biren Roy Trust fellowship would be awarded to Dr Bhaskar Dutta, a fellow in the Bangalore based Indian Institute of Astrophysics, for his outstanding contributions in the field

Manager

THE duty of a manager, in an organisation, is to ensure its efficient and smooth functioning, by way of allocating resources and facilities in a way that they are optimally utilised A manager's job, in short, is to get other people do theirs in the best possible manner

Likewise, a computer too has a manager to control and coordinate its various activities The computer manager is called its *operating system* (OS) It is nothing but a special program whose job is to manage other programs The OS monitors the working of each program and allocates the computer's resources in a way that optimises their use It provides for convenient and reliable use of the system to the users Without it, the computer is as good as a car minus its steering system The OS, being so crucial to the use of a computer, is always supplied along with the unit

The power and usage of computers have increased enormously over the years, requiring operating systems to tackle increasingly complex management tasks. We can say that these are among the most sophisticated and complex programs designed today In the following we see what they can do, not bothering about how

The first operating systems to be created can be traced to the days of punched cards The program and the data needed were fed to the computer as a bunch of cards, then Typically, the cards were collected by an operator and queued up on the card reader for execution, one by one Those were the days when many programmers shared the few existing machines and computing was much more expensive

The job of the operating system was simple enough here It read one program at a time from the cards into memory (a computer, it should be recalled, has a central processing unit (CPU) which reads the program stored in the memory and executes it instruction by intruction) This operation is called *loading* the program Once loaded, the execution would start When the program was completed or ran into error the OS loaded the next program Thus, the main task of the OS was to sequence, automatically, the programs The situation here is very much as at a railway ticket counter with programs instead of people and the OS replacing the clerk We call this system a *simple batch OS*

Loading a program into memory is not as easy as it sounds The OS already present in the memory has to load another program into it The problem was solved by providing a separate memory for the operating system which was inaccessible to the user program Hence, the OS could run continuously, even if there were errors in the user programs The interesting question is, how OS itself is loaded This is done with the help of instructions permanently inscribed in the memory

A major concern of the early OS designers was the efficient use of computers Unfortunately, the simple batch system proved to be the most inefficient way of using them To illustrate this point, let us consider a simple program to find the average of a thousand numbers The card reader reads the number and the CPU then goes on to do the necessary addition or division How much time does it take for the card reader to read a card? Being an electromechanical device, for each card it takes nearly 100 milliseconds (a millisecond is a thousandth of a second) It is a long time indeed for the central processing unit or CPU It could have carried out nearly 10,000 operations in this time But CPU has to wait for each card to be read before it can act In such a case the program is said to be *blocked* on input A program which gets blocked frequently as here (nearly a thousand times) is said to be *input/output bound*

In general, all input/output (i/o) devices such as card readers, magnetic tape units and magnetic disk units are electromechanical devices which tend to block programs. Whenever this happens, the computer sits idle and there is a wastage of precious computer time

Buffering

The solution to this problem is two fold The operating system could ask the card reader to read the card much before the program sends a request for it This data could be held in a special part of the memory called *buffer* In this *read-ahead* technique, when the program needs the data it requests the OS for it. The program does not get blocked, usually, as the data is already in the memory A similar technique applies to the printer, an output device In practice, the OS can maintain a number of

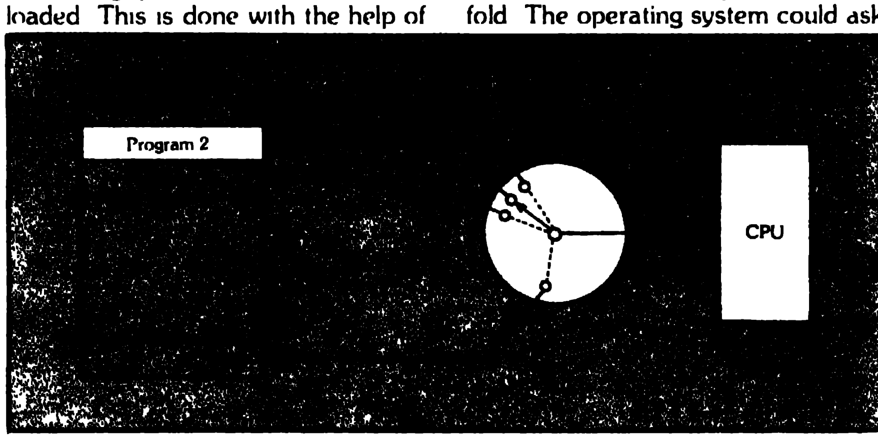

Fig 1 Schematic of a multiprogrammed operating system

S. Arun-Kumar
R. Chandrasekar
Kamal Lodaya
Paritosh Pandya
R. Ramanujam

buffers, increasing the efficiency of computing

The careful reader would have noticed that all i/o devices are now controlled by the OS, rendering these independent of the program Such systems are said to be *asynchronous* to the program The user program is not allowed to control the i/o devices directly It issues special calls provided for this purpose, the system calls READ and WRITE instructions we saw earlier will be translated into system calls Controlling an i/o device is a complex operation, and it is much easier to use a system call for the programmer

In spite of buffering, the program could get blocked if data were needed very frequently There is a limit on how fast the read-ahead could supply the data Although, now the idle time is much less than before, the efficiency is not high enough, especially with i/o bound programs This drawback motivated another change in the OS

Switching between programs

This improvement in the OS design was made when it could function as a switch between programs Many programs were now held in the memory simultaneously and when one program was blocked the OS would switch another program to the CPU This technique is known as *multiprogramming* (Fig 1) At any time only one of the programs held by the memory is being executed Other programs are either 'ready' and waiting for the CPU or 'blocked' at some system call. The OS records the conditions for which the programs are blocked (program PAYROLL may be blocked because it is waiting for the input of the next record from the MASTER file) Whenever the required conditions are met, the OS unblocks the program and makes it ready All this book-keeping by the OS regarding the state of a program is termed *process management* and is one of the main tasks of the OS The life cycle of a program in such an operating system is shown in figure 2.

In addition, the OS keeps track of the free portions of the memory and the parts occupied by each program On completion of a program, the OS releases the memory space it had occupied Whenever enough memory is available, a new program is loaded, automatically

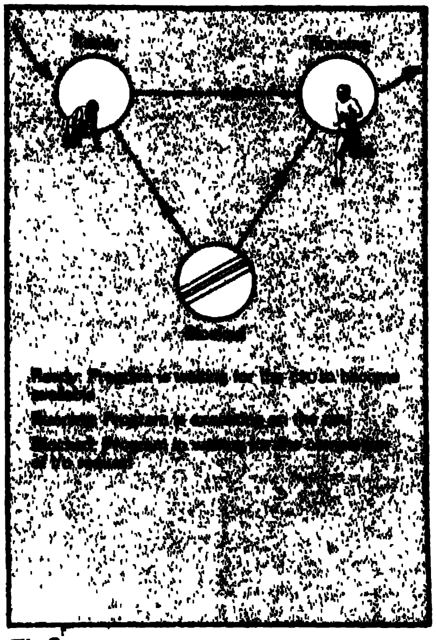

Fig 2

By now, the OS has taken over these main functions

* i/o device management
* Buffer management
* Process management
* Memory management

Swapping

Computer memory is not unlimited Even in a multiprogramming batch OS, it can happen that all programs in the memory get blocked and CPU is forced to idle

A very ingenious solution has been found to this problem Most computers are equipped with magnetic disk units which can store large amounts of information, of the order of 200 million bytes Further, the information transfer from a disk to the memory can be made at a reasonably high speed Once given a command to transfer information, the disk can do it without the help of CPU This important characteristic of the disk leaves the CPU free to execute programs and the disk is said to be in *direct memory access* mode

The OS can now keep most programs on disk instead of in memory A few ready programs stay in memory and the CPU is allocated to them as before No sooner a program gets blocked, it is transferred to the disk and a new program loaded into its place This operation is called *swapping*

With swapping, a multiprogrammed batch-OS can keep many programs active simultaneously Even as swapping goes on CPU is free to execute some other program in the memory In such systems programs migrate to the memory for execution and return to the disk, if blocked, for hybernating The memory space is no longer locked up by the blocked programs Figure 3 illustrates this schematically

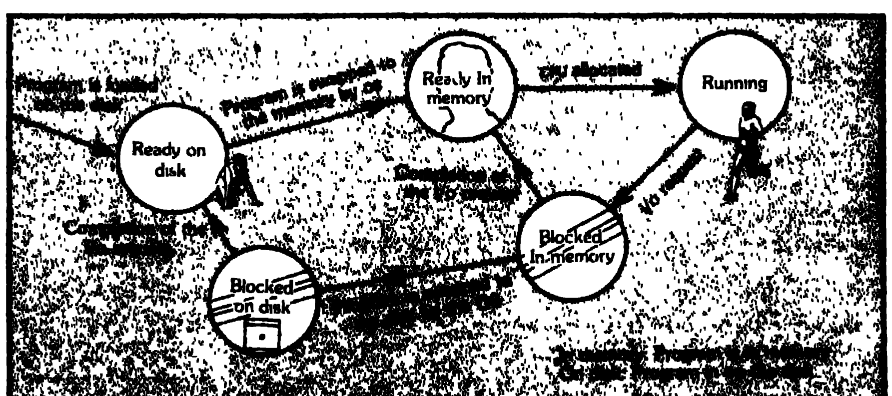

Fig 3 Life cycle of a program in a multiprogrammed batch OS with swapping

These developments in the OS greatly helped towards the efficient use of computer resources Meanwhile, a new mode of using the computer came into practice requiring further changes in the OS

Time-sharing

In the mid sixties, computers were equipped with teletypewriters (TTY's) and later with terminals A terminal is an i/o device, with a typewriter-like keyboard and television-like screen for displaying the results Now a user could communicate directly with the computer Interactive programs allow the user to carry out a dialogue with the computer even while the program is getting executed Interaction facilities were provided for the user to monitor and control the execution of the program

In interactive programming it is necessary that the computer respond to the user's queries within a short time ' Multiprogrammed-batch systems are unsatisfactory in this respect They are designed with the efficient use of computer in mind Hence they permit a program to use the CPU for any length of time unless the program gets blocked When this is the case, other interactive programs are denied the access to CPU which is disastrous A user would be kept waiting too long for a response from the computer Hence, it is best if the CPU could be shared among the different users irrespective of the nature of the programs To realise this a clock was added to the computer system The clock sent signals to the OS at a regular interval (typically 20 to 100 milliseconds) On each clock signal the OS would take away the CPU from the executing program and allocate it to the next. In Figure 1, imagine the switch to be equipped with a clock Everytime the clock signal is received, the switch makes a different connection We say that the CPU is time shared between programs The operating system with this feature is called *time-sharing* OS

This scheme provides more or less equal time to each user. If there are 20 programs in memory and the clock signal is every 100 milliseconds, all programs will be attended to every 2 seconds Hence the response time of an interactive program does not deteriorate due to other programs (Fig 4)

Virtual memory

So far, we have assumed that the entire program must be loaded in the memory for its execution Logically, this condition can be relaxed The CPU can execute only one instruction at a time. Hence at any instant only one instruction of the program needs to be in memory, the rest may be even on disk However, it is quite impractical to bring each instruction from disk to memory when needed So an intermediate approach is adopted

Let us explain how such a system works by an analogy Banks maintain their clients'accounts in ledgers, each ledger contains a few accounts The accountant, who has a limited desk-space, keeps only a few ledgers on his desk Other ledgers are kept in a 'library' An attendant brings ledgers from the library when needed and returns them back to the library when not in use This prevents the accountant's desk from getting cluttered The same technique is used in operating systems too The program is divided into small parts called *pages* Typically, each page contains about 1000 instructions Only a few currently active pages of the program are kept in the memory The rest of the pages are kept on the disk.

The CPU executes the program instructions as before. Most of these instructions and data are available within the pages present in the memory However, occasionally, the CPU refers to an instruction or data word contained in a page not present in the memory. We say that a *page-fault* has occurred Whenever a page-fault occurs, the CPU requests the operating system to fetch that page from the disk The program gets blocked The OS first writes back one of the pages in memory onto the disk This creates some free space in the memory The required page is brought into this free space from the disk Note that this is just the swapping operation carried out in units of pages (compared to swapping whole programs in the earlier design) Once the required page becomes available in the memory, the OS unblocks the program to a ready state (Fig 5)

The advantage of such a scheme is that the program can be much larger than the actual memory This is because only a part of the program is in the memory at a time It is not uncommon to find programs 4 million words long being executed on a computer with memory size of 1/4 million words The operating system may have upto 16 such programs active simultaneously This means that on an average only 1/256th of a program is in the memory at a time!

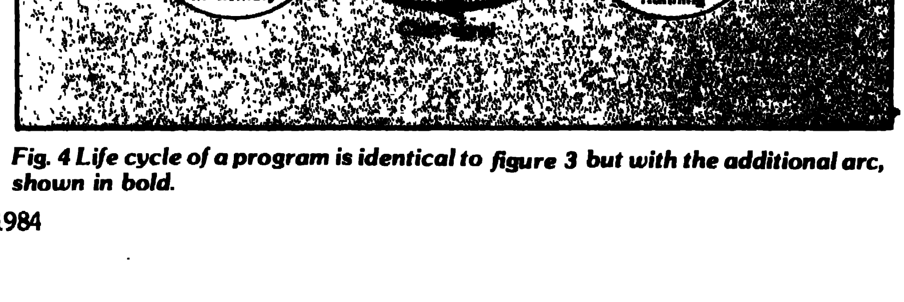

Fig. 4 Life cycle of a program is identical to figure 3 but with the additional arc, shown in bold.

With such a memory management scheme, the user program can assume that it is using a computer with a very large memory. The fact that his program is executed by the operating system on a computer with much smaller memory is completely hidden from the user program and does not affect its working at all! So we say that the operating system provides the user with *virtual memory*.

In fact we can go further. The fact that a single computer is time-shared between many user programs simultaneously is also hidden from the user program and does not affect its working. A user program can assume that it is executing alone on its own computer. We say that the OS provides each user with a private *virtual computer*, which has a large virtual memory. It also has many 'virtual' instructions not directly available on the actual computer, such as READ, which are implemented as system calls. With all these facilities the virtual computer is far superior to the actual computer. The main challenge of operating system design is to provide a good virtual computer to each user and to implement different users' virtual computers on a single physical computer efficiently. A good example of such an OS provided facility is the file system.

File management

A computer user has normally a wide repertoire of programs. The user identifies his files by appropriate names, e.g. LETTER TEXT, PAYROLL DATA etc. The user organises his files on the computer very much as it is done in an office. Files in an office are classified and the related files are tied up in bundles. The related bundles are kept in the same cabinet. A computer user collects his related files into groups called *directories*. Directories can themselves be grouped into larger directories.

Files are stored on disks. One disk usually stores files belonging to many different users. The *file system* is the component of the operating system that manages the files and directories

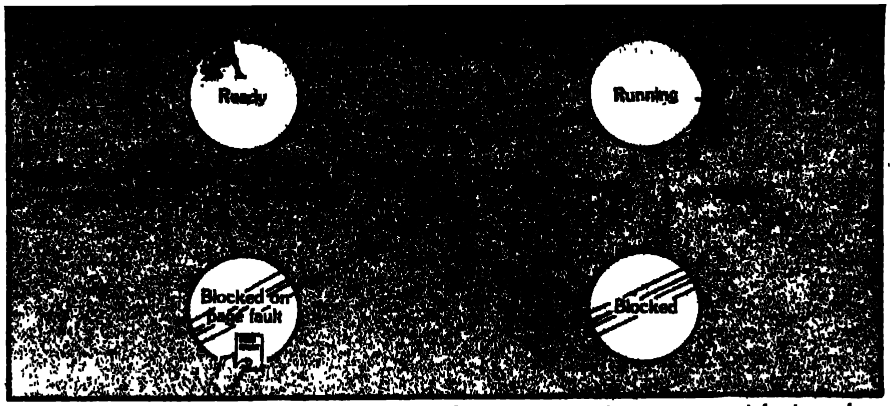

Fig. 5 Life cycle of a program in a time-sharing operating system with virtual memory. The program is blocked on a page fault

of all users. The file system keeps a record of the free space on the disk and allocates storage space to a new file when it is created. It also provides system calls to read or write records in a file. It ensures that such a read or write operation succeeds only if the user has the necessary permission to carry out this operation.

In accordance with their new function of making the computer easy to use, OS provides several programs to the user. EDITOR, an interactive program that allows a user to write information into a file and COMMAND HANDLER which accepts commands from the user and carries them out, are two examples. These *system utilities* are frequently used by all programmers in developing and using their programs.

New trends

A time-sharing operating system, as we saw, distributes the CPU among the many programs. However, if the number of programs is very large the CPU is granted to each program at long intervals. When this happens we say that the OS is overloaded.

Suppose there are 50 users and a response is required every 2 seconds. The clock signal must then be at every 4 milliseconds. But in this time very little computation can be done. Programs do progress but rather slowly. To overcome this problem, computers with more than one CPU (but only one memory) have been designed. Such processors are called *multiprocessors*. On a multiprocessor, the time-sharing OS can allocate the CPUs to many programs simultaneously. Both the response and the speed of execution improve greatly as each program receives the CPU more frequently. A multiprocessor OS can be compared to a system of switches.

With all this increase in complexity, the operating systems became very difficult to design. It took years to produce an operating system for a new computer. Further, the reliability of the operating system was low. Most of them contained errors which were detected only after years of use. In short, they started showing tendencies of becoming white elephants.

Meanwhile, with advances in electronic technology, the cost of computers came down drastically and their speed increased significantly. It is now feasible to provide each user with a personal computer. Personal computers offer many advantages over a time shared computer, they support extremely powerful utilities with sophisticated interaction methods, their operating systems are considerably simpler and so on.

Personal computer suffers from a serious disadvantage, however. It is meant for a single user, and hence one cannot access the files and programs of other users. This problem is solved if a number of them are connected to each other with data carrying links. These connections may be telephone lines, satellite channels, or even plain wires depending on the distance and amount of data transfer. Such *networks* with computers scattered at different geographic locations are coming into use.

Managing a network of computers to make them perform their tasks cooperatively is indeed a difficult task. The problem is compounded by the fact that messages sent get corrupted in transit or even get lost because of the unreliability of data links. Network operating systems are an active field of research today. □

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Depression, a modern term for melancholia, is a common mood (affective) disorder with a long ancestry The others in this group of disorders are mania and anxiety neurosis

Among the victims of depression are the characters from the Indian epics- -Arjuna, Dasaratha and Rama Monarchs, presidents, prime ministers, artists, poets, creative thinkers and scientists have also had their share of depression. Economic and social status confer little protection against the illness King George III of England, Lincoln, Roosevelt, Churchill, Van Gough, Darwin, Goethe, Tolstoy, Virginia Woolf are a few in the roster among others from their respective spheres *The anatomy of melancholy* is an autobiographical account of the depressive illness of Robert Burton The celebrated passage of John Donne suggests as to how he wished to fight the anguish "No man is an island, entire of itself, every man is a piece of the continent, a part of the main any man's death diminishes me, because I am involved in mankind; and therefore never tend to know for whom the bell tolls, it tolls for thee" Similarly, Vincent Van Gough "preferred a melancholy that aspires and searches, to a melancholy that is stagnant and mournful and leads to desperation "

Claimed once to be exclusively confined to the inhabitants of the British Isles, depression or the 'English spleen' as it was known earlier, is now world-wide in its spread. Nearly 100 million people in the world suffer from depression each year. It is a diagnosis that recurs at every level of clinical experience and yet escapes detection by the public and also by the professionals Those suffering from depression, who contact doctors, form the visible part of the iceberg. Many are unaware of their illness and they attribute it to the 'problems of living' which are not to be mistaken for an ailment Hence, much of the depression in the community remains hidden leading to a lot of avoidable morbidity

A study from Chandigarh indicates that nearly 20 per cent of patients seen in general medical practice suffer from depressive symptoms with or without any physical illness. Five per cent of patients suffer from depression alone There are indications that the next few years will witness an enormous number of depressed people owing to causes generated by our times The life expectancy has increased all over

Clinical Depression

A. Venkoba Rao

the world, including in the developing countries bringing in its train a larger number of people who are vulnerable to mood disorders

In a Mental Health survey carried out recently near Madurai, depressive illness was found to affect 60 persons thousand among those aged sixty and above With the added years to life, the elderly also run the risk of diseases of the heart and circulation, brain and nerves and of the collagen tissue Twenty per cent of the people affected by these diseases are known to suffer from depression

The drugs which are used to treat high blood pressure, and psychotropic agents which are used for mental illness like tranquillisers, barbiturates, and hormonal preparations such as ACTH (adrenocorticotropin hormone), cortisone and contraceptive pills tend to induce 'iatrogenic' (doctor-induced) depression There has been an increasing use of these depressogenic drugs over the years The fast disappearance of the protective influence of the family and social support, a sense of 'anomie', a dessication of values, a mode of living bereft of ethics, and a state of 'existential despair', though not necessarily peculiar to our age, have contributed to augment the numbers depressed

This affective disorder, depression, is familial, i e, close relatives of those with illness are more likely to suffer than the unrelated ones Studies in twins suggest that a genetic factor is responsible for the illness, since 65 per cent of monozygotic twins (identical) and 14 per cent of the dizygotics (non-identical) are prone to the illness Adoption and family studies have lent support to the genetic contribution The exact mode of transmission is yet to be determined though a recent study indicates a *Duarte* protein linked with HLA (human lymphocyte antigen) gene to be involved Examples of the familial occurrence are that of Mary Woolstonecraft, mother-in-law of the poet Shelly and the family of Ernest Hemmingway.

Chemistry of depression

Biochemical reseaiches have shown that the illness is related to an abnormal chemistry of the nervous system According to the prevailing biogenic amine (chemicals present in brain) hypothesis, the functioning level of monoamines (serotonin, norepinephrine) at the central synaptic receptors, where a nervous impulse passes from one neuron to the other determines the occurrence of affective illness—excess of it causing mania and its deficiency leading to depression

What causes these changes in the amine levels remains unknown Anti-depressant drugs of tricyclic and tetracyclic class and MAO (mono amine oxidase) inhibitors are known to adjust the level, bringing an improvement With proper precautions, these can be administered even in the community by general practitioners and trained health personnel The other suspected biological faults involve endocrine dysfunction and electrolyte changes

Apart from the low levels of biogenic amines in depression, certain neurophysiological findings have also been recorded A dysfunction in the hypothalamus and the limbic system, that control moods, is known to occur. The neurotransmitter function in these areas of the brain may be affected due to the low levels of biogenic amines. The neurophysiologic basis of depressive illness is yet to be clearly worked out

The use of lithium in psychiatry was introduced by Dr John Cade of Australia in the late 1940s but its action is not exactly known Several mechanisms underlying its effects have characterised the illness Its action on the cell membrane affecting the transport of sodium and potassium whose distribution within and without the cells is abnormal in the disease has been indicated Lithium is also known to affect adenyl cyclase in the synthesis of ATP, the second messenger in neurotransmission It has also been speculated that lithium sets right the abnormal biological clock that underlies Manic Depressive Psychosis (MDP)

Lithium has ushered in a new chemical revolution in the management of depressive illness It is unique in preventing relapses, and is a major discovery in mental therapeutics.

The metallic drug, however, should be used with caution and only by those who are familiar with it During the last eight years the lithium clinic in our department has proved the drug's manifold benefits to the depressed The relapses have been effectively averted in many and in cases where relapses recurred, these were mild and brief

The most interesting observation has been the total absence of suicidal tendencies in lithium treated subjects Here is an instance of chemoprophylaxis (prevention of disease using chemical agents) for self-destructive behaviours Lithium is indispensible in a modern suicide

Depression in women

Severe depression and/or anxiety of comparable severity is more common in women and working class people This was established by George W. Brown and Tirril Harris, Bedford College, London in 1978 They selected about 458 women randomly and asked each to narrate the stressful events—"life events" over the preceding year About 8 per cent of this group had onsets of depression during the preceding year while 9 per cent of those interviewed had chronic depression Initially it was difficult to explain why some women became depressed when they suffered a serious adversity while four-fifths of those suffering from an equally severe blow did not However, on further research, Brown and Harris found a series of factors which was distinctly different from events and difficulties, now called as "vulnerability" factors A vulnerability (V) factor does not induce depression on its own A common V-factor they discovered was an absence of an intimate relationship with either husband or lover.

The V-factors responsible for causing depression are different in our country. These factors mostly depend on the society and the environment we live in, factors like having to look after more than three children, bereavements, broken-marriages, infertility, living in overcrowded areas, or having to cope with a drunken and violent husband can be a few of the known causes of onset of depression in women.

A woman usually is said to have a period of depression after pregnancy and child birth Also, premenstrual tension is accompanied by a wave of depression which passes off soon Indian women, however, do not get depressed easily, as their male counterparts

P.R.S.

The next few years will witness an enormous number of depressed people owing to causes generated by our times

prevention clinic The English workers have reported that one-fifth of the number of suicides out of depression are preventable using lithium.

Signs and symptoms

Depression generally sets in suddenly as if out of the blue. There are others who are unable to tell the beginnings of the disease as its onset is insidious The symptoms may be mild or severe, illness lasting for a few weeks to a few years Recurrences occur in many There may be a triggering incident in the form of a 'loss': like the loss of one's child or a spouse, fortune, of health by a serious illness, of the job by retirement or dismissal or of a home due to migration.

A psychological or a spiritual crisis, or damage to one's self-esteem may be operative in others Depression is common in the inmates of penal institutions—prison blues Depression, occurring in response to a stress, is called 'reactive depression' Its course is mild and clears up in a few weeks In practice it is difficult to assess stress — "What is a great stress for one may be shrug of the shoulder for the other" The individual is overcome by a lack of feeling of joy, interests and initiative Bemoaning the change that crept over him during the years, Charles Darwin said "In one respect my mind has changed now for many years, I cannot endure to read a line of poetry I have lost also taste for pictures or music The loss of these means loss of happiness " There is a gradual withdrawal from one's social relationships and from occupational field An inability to participate in the family affairs, indecision, procrastination and inaction are common Many remain housebound

Slow thinking, defective concentration and poor ideas are inaugural symptoms Some proceed to mutism A lack of confidence, a sense of hopelessness, helplessness and despair may be overwhelming Pessimism is the tune of depressive orchestra The person feels insecure, expresses guilt and blames himself over imaginary or real acts of omissions and commissions A feeling of uselessness, of being a burden to the family and to the world pervades He desires punishment either from himself or others. In this frame of mind the patient may even refuse treatment believing in its futility. Ideas of suicide overtake him and in spite of his attempts to circumvent them, he may succumb. "The thoughts of suicide came to me as naturally as thoughts of improving life had come to me formerly This thought was so tempting that I had to use guile against myself so as not to bring it to fulfilment too hastily" wrote Tolstoy. The patient convinces himself that his life has been a grand failure. "I have achieved a great deal but I have achieved nothing in the end" lamented Winston Churchill in one of his spells of the "black dog". To the depressives, time passes but slowly "A day is a millennium" is a common complaint In many, the illness is marked by an assortment of bodily symptoms which takes them to the non-psychiatric physicians Persistent sleeplessness, vague or even severe aches, pain in the body— head, neck, chest, abdomen-not attributable to any physical disease or responding to treatment, are common

An inexplainable loss of strength, a gradual loss of appetite, with no taste for food and dyspepsia leading to loss of weight, a decline in sexual interest, a persistent constipation prove troublesome These physical symptoms, without a frank depressed mood constitute "masked depression" Many go through unnecessary investigations and surgical procedures In others, fears and agitation may be disturbing In a typical depressive, the lack-lustre complexion and the face reflects the inner gloom A few resort to alcohol to lift themselves out of depression Others take to sleeping, exercise and stimulant drugs

It is well known that drinking and drug abuse are not uncommon expressions of depressive illness In such cases the treatment is rewarding when directed to the underlying depression. Marital conflicts, separation and divorce are unfortunate accompaniments of the illness. Out of disgust, shame and for reasons of conscience a few depressives offer resignation from their jobs. In extreme cases, engulfed by a pathological desolateness the depressed individual kills his wife and children and himself—an act of "extended suicide" Electro-convulsive treatment, a safe technique, dramatically improves the depressed with self-destructive notions and is the treatment of choice, since there is a lag period of two weeks before the antidepressant drugs become effective. A suicidal depressive is a psychiatric emergency, needing a quick treatment

In about 30 per cent of the cases, depression swings towards elation, its polar opposite In this state, the opposite of depression-volubility, ceaseless activity, absence of fatigue embarking on ill-advised but grandiose projects, reckless spending, crowded ideation, irritability and argumentativeness and even violence, and a failure of perception of the illness Such menacing moods may be devastating to the family's emotional health and economy This elevated mood constitutes mania, a fraternal sister of depression If the course of illness is punctuated by mania as well as depression, the condition is one of MDP Depression or mania can occur by itself and recur at varying intervals of time

Psychotherapy, a treatment by psychological means, aiming at a change in the pattern of living, offering emotional support, and a reasonable solution for conflicts is always called for in every case of severe depression

Depression, a recurring illness, affects personal health, bringing psychological misery, precipitates domestic unhappiness, entails a loss of man-hours, and is a significant cause of mortality through self-destruction It needs recognition and is easily treatable, and when cured, leaves no defects. □

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SOLAR WATER PUMPS

R. S. Soin

THE importance of developing a cost-effective solar water pump for irrigation in a developing country can hardly be overemphasised. The pumps now used in irrigation are mostly run on diesel or electricity. By 1981, there were 2.8 million and 4.3 million such pumps, respectively, and by the year 2000, the total number of electric motor pump sets is expected to be 20 million. However, because of the constraints on power generation and inadequate supplies of oil, solar powered water pumps hold tremendous potential if they are cost effective.

There has been a lot of interest in the last decade in developing such a device. Unfortunately a satisfactory solution is still to be found. Although several solar water pumps have been built and demonstrated all over the world, their cost is still prohibitive. There are mainly two routes for harnessing solar energy for pumping water. In one, solar energy is converted, through photovoltaic cells, directly to electrical energy which in turn powers a water pump. In the other solar energy is collected as thermal energy, through solar collectors, (SCIENCE TODAY September 1983 p 19), which is utilised to produce either electrical or mechanical power to run a water pump. Of the two technologies, the photovoltaic route is receiving much attention and is likely to dominate for small power needs, mainly because it is simple to operate, highly reliable, needs little maintenance, and has a long life. The thermal route has low efficiencies and needs a considerable amount of parasitic power, especially for small capacities.

In our country, the Central Electronics Limited manufactures silicon photovoltaic or solar cell panels and pumping units. Recently Bharat Heavy Electricals Limited Bangalore, has also gone into production. And as many as 137 demonstration units have been installed all over the country. These pumps are of 300 watts peak(Wp) each and can pump 30,000 to 40,000 litres of water through a head of 5 to 6 metres on a bright sunny day.

The Department of Non Conventional Energy Sources (DNES) Government of India, offers much subsidies and solar cells are sold at Rs 110 per watt peak while a 300 Wp water pump is sold at Rs 25,000. The DNES is also further subsidizing pump sets, under the national photovoltaic demonstration programme in rural and selected remote areas at Rs 5,000 per pump set.

How do the two systems of water pump sets work?

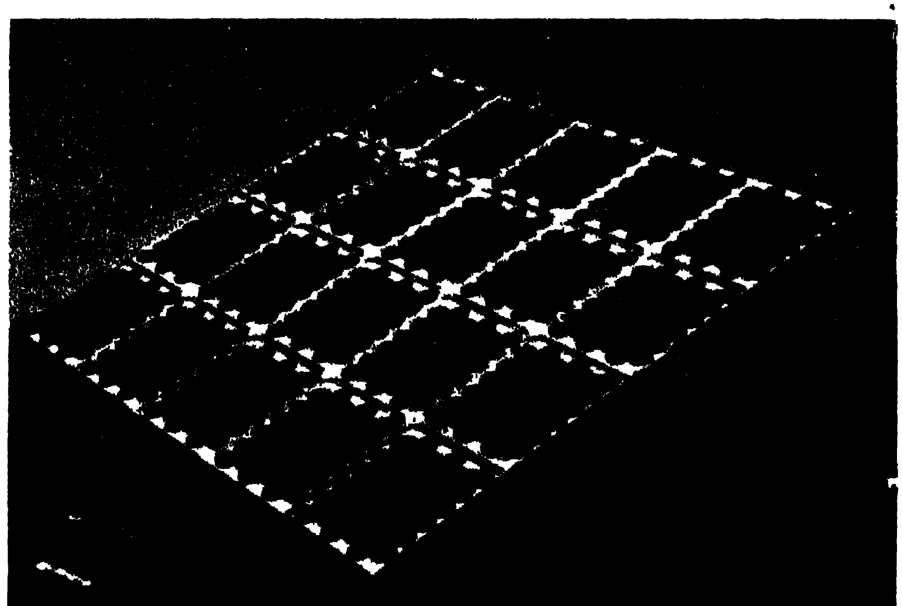
The photovoltaic systems

Photovoltaic cells convert solar radiation directly into direct current (DC) electric power which in turn can be used to run a motor pump set (Figs 1 and 2). The system mainly consists of a photovoltaic array, battery storage and a DC motor pump set. The configuration shown in the figure is the simplest with battery storage only as an option. The photovoltaic panel comprising of cells in series and parallel, is the heart of the system and also accounts for much of the cost. To date, commercially available photovoltaic cells are either single crystal silicon or polycrystalline silicon. Others which are showing promise are amorphous silicon cells, cadmium sulphide copper sulphide cells and high efficiency gallium arsenide cells. Single crystal silicon cells have an efficiency of about 12 to 15 per cent; for the rest, it ranges from 4 to 28 per cent.

The advantage of using a battery storage is that it can provide a steady supply of electrical energy even if the photovoltaic array output fluctuates considerably due to changes in solar radiation. But virtually a control system is necessary to regulate battery-charging and to switch on and switch off the motor pump set according to the battery charge level. This adds to the cost, requires regular topping up with distilled water, gives rise to significant loss as the charge-discharge cycle is only 60 to 80 per cent efficient and finally the system may not last more than five years. For small irrigation pumps, therefore, using battery storage may not be advisable.

There is another useful option — the maximum power point tracker (MPPT) which monitors the photovoltaic cell array voltage to match the array operating level to motor demand. This causes the system to operate at the maximum power at a given load condition. If the solar radiation level

Fig 1 The photovoltaic panel is seen prominently in this irrigation water pump installation



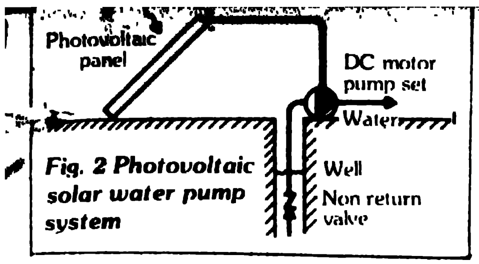


Fig. 2 Photovoltaic solar water pump system

Solar water pumps based on photovoltaic cells hold much promise for irrigation

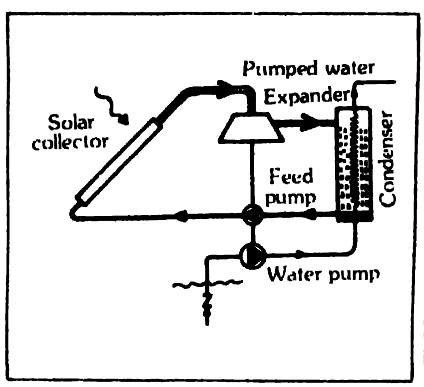
array temperature, pumping head or any other condition changes, then the MPTT seeks a new maximum power point This gives significant benefits in systems using a positive displacement pump like the domestic head pump or any well matched system However, the MPTT consumes 4 to 7 per cent power This loss should be weighed against the benefit it offers While it is possible to obtain a photovoltaic array efficiency of 10 to 15 per cent for single-crystal silicon, the DC motor pump set efficiencies available in the country do not exceed 50 per cent especially the ones with fractional horse power capacities In certain cases, an invertor is used to obtain AC power and then employ an efficient AC motor pump set but this again involves additional cost and complexity Since photovoltaic power is expensive in view of the high cost of solar cells, it is imperative to develop a more efficient pump either through a magnetic coupling or by using better materials and optimum designs

Thermal systems

In water pumps based on the Rankine cycle system, a working fluid like water or freon is vaporised either directly in solar collectors or in an evaporator and the high-pressure vapour is passed through an expander When the vapour expands from high pressure to low pressure, it delivers useful power which is transmitted through a mechanical or hydraulic coupling to the pump The spent vapour is condensed in a condenser and pumped back through the feed pump The control valves regulate the vapour flows The pump system thus essentially consists of solar collectors, evaporators, expander, condenser feed pump, control valves and a hydraulic pump Figure 3 shows the simplest arrangement of such a Rankine cycle based system

For pumps using flat plate collectors or other collectors (SCIENCE TODAY, September 1983, p 19) which yield temperatures of up to 100°C, organic fluids such as freons which have a low boiling point and are non inflammable are used Water is preferred for evaporator temperatures ranging from 120° - 300°C which are obtained by concentrating collectors In case of water, it is not critical to contain it totally

The Dornier (West Germany), Solar Pump Corporation (USA), and Sofretes (France) use the Rankine cycle in conjunction with flat-plate collectors Although several of these pumps have been installed all over the world, proving their technical viability and reliability, they do not make economic sense in view of their low overall efficiency of about one per cent Incidentally, BHEL has installed a Dornier pumping system which has been running satisfactorily for over three years in Hyderabad The pump employs high-efficiency heat pipe (a heat-exchanger device) solar collectors the controlling mechanism is such that the engine runs automatically when enough solar insolation strikes the collectors The overall



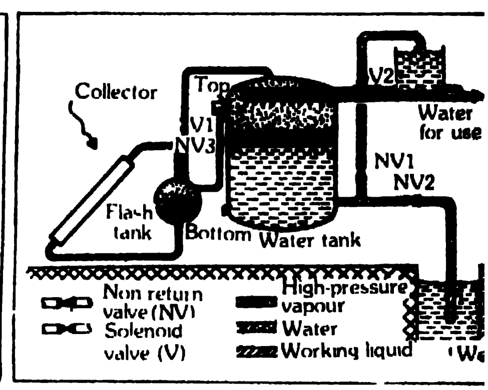


Fig 3 (left) Rankine cycle solar water pump Fig 4 (right) Solar water pump with non-moving parts

efficiency reported is about two per cent The major problems associated with solar thermal water pumps based on the Rankine cycle are providing power to the feed pump lubrication and sealing systems

In this class is another type which uses vapour expansion directly for pumping One such solar water pump is shown in Fig 4 This has been developed initially at the Birla Institute of Technology and Science, Pilani, and later improved at Hindustan Brown Boveri, Baroda, the Indian Institute of Technology, Kanpur, and the Central Salt and Marine Chemicals Research Institute, Bhavnagar Operationally, the working fluid is vaporised directly in a solar collector and the high pressure vapour enters the water tank, effecting pumping Whenever the water in the tank reaches the bottom level, the vapour valve closes automatically while the water valve is opened to allow water to pass through the cooling coil The vapour in the tank is condensed, creating partial vacuum in the water tank which draws water into the tank from a nearby water source The working fluid should not mix with water and its boiling point should be slightly higher than the cooling water temperature One such fluid is n pentane, but being expensive, commercial petroleum ether 40°-60°C is used it contains 60 - 70 per cent pentane and the rest is hexane Many variations of these pumps have been proposed based on how the spent vapour is condensed, the use of a diaphram and whether the pumping is continuous or intermittant Such pumps have efficiencies normally not more than one per cent, they have a limited suction depth and they need an open well or a pond or a river as the water source for its operation The table on p 52 summarises the various research and development efforts on solar water pump in our country in the recent past

SOLAR WATER PUMP—R&D WORK IN INDIA

Type	Organisations working	Comments
Solar water pump with no moving parts	Birla Institute of Technology and Science, Pilani IIT, Kanpur. Central Salt and Marine Chemicals Research Instt., (CSMRI) Bhavnagar, and Hindustan Brown Boveri Ltd, Baroda.	Low efficiencies (about 1%) Suitable to open wells, tanks canals, etc. Limited suction problems associated with maintaining vacuum. Prototype tested upto 0.5 h.p.
Solar water pump with diaphram	Central Mechanical Engineering Research Instt., Durgapur	Low-efficiency (about 1%) laboratory model was built
Reciprocating engine working with low-boiling organic fluid	Field Unit, Tata Energy Research Institute, (TERI) Pondicherry Central Salt and Marine Chemicals Research Institute, Bhavnagar Bharat Heavy Electricals Limited, Hyderabad.	TERI tested Sofretes pump with butane as working fluid. CSMCRI built a fractional h.p. prototype and carried out performance studies. Efficiency less than 1%. Sealing and lubrication are critical problems. BHEL installed Dornier pump and operated for 3 years. A higher capacity pump is designed to fabricate locally.
Abhimanyu pump	National Physical Laboratory, Delhi School of Energy Studies, Poona University, Poona	Spiral expander; problems associated are leakages and lubrication. Efficiency reported is about 2%.
Steam engine	Jyoti Energy Division, Baroda Jyoti Solar Energy Instt, Vallabh Vidyanagar, Gujarat	5 h.p. prototype has been tested. A 5 kW machine is being assembled to work with linear parabolic concentrator.
Stirling engine	Central Salt and Marine Chemicals Research Institute, Bhavnagar	Built a 0.17 h.p. prototype. Problems observed with sealing and heat transfer.

Stirling engine

The stirling engine, theoretically, has a higher efficiency than the Rankine cycle for a given temperature. Practically, however, temperatures greater than 400°C are preferred for stirling engine operation. The working fluids used are normally air, hydrogen or helium. Besides its high efficiency, the stirling engine is rugged, and comparatively maintenance-free in view of external heating. Another advantage is that alternative fuels such as biogas or biomass can be used in place of solar heating on a cloudy or rainy day or night time operation.

Two types of stirling engines have been proposed so far. One is the kinametic engine and the other is the *free piston engine* and they differ in the linkages between the power piston and the displacer. Although large size kinametic type stirling engines have been built and tested for transport applications using gaseous fuels, neither kinematic nor free piston engines have been built and tested with solar energy as the input for large irrigation purposes. Beale of Sun Power Corporation, USA has built a free-piston stirling engine with a fractional capacity which can run on natural gas.

The main problems associated with stirling engines designed to work on solar energy are the regenerator (a heat transfer device) design, taking into account the transient heat transfer, the receiver design coupling the engine with the concentrator and the transfer of the heat to the working fluid from the receiver.

The realistic costs of solar water pumps are not available since these pumps are still in the developmental stage and continuous technological improvements are taking place. Only some indicative costs are available. The present cost of Rs 110 per peak watt of photovoltaic cells may come down to half in the next few years. The cost of solar thermal water pump greatly depends on the type of solar collectors and their efficiency at the desired temperature.

Both photovoltaic and solar thermal water pumps have been extensively developed and studied in India. The photovoltaic solar water pump has made much headway in terms of reliability and cost-effectiveness and hundreds of installations are already working.

The recent technological developments of amorphous and polycrystalline silicon solar cells seem to hold great promise. Efficiencies upto 6 to 8 per cent are claimed for amorphous silicon solar cells and the costs are predicted to come down as low as Rs 25 per peak watt in the next five years. Meanwhile interest in developing a solar water pump using flat plate collectors is decreasing in view of its low efficiencies and it is increasingly becoming clear that it can not compete with photovoltaic systems for small power needs. The solar powered stirling engine holds promise in view of its high efficiency and capability to adopt to locally available rural energy resources such as biogas and biomass. □

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Is intelligence inherited?

Bal Phondke

EORGE Bernard Shaw is said to have been approached with a marriage proposal by a ravishing young actress. The woman thought that the child born from such a wedlock would derive its beauty from her and its intelligence from the father! The wily dramatist reportedly escaped matrimonial bondage with a typically Shavian disclaimer "What if the baby were to get my looks and your brains?"

Levity apart, the story underlines the popular belief that beauty and intelligence are both heritable "characters". Beauty, if not exactly skin-deep, is, at least, composed of external anatomical features. There is reasonable evidence to suggest that the design for these features lies in the genes. The striking resemblance in the facial features and body-build of identical twins should be an acceptable proof of this. But what of the cerebral quality? Is intelligence indeed inherited?

The answer to that intriguing question is yes, not only in the minds of laymen but even among some of the highly respected members of the intelligentsia. How else can one explain the heretic concept of a Nobel sperm bank and its unashamed advocacy by William Shockley? Such concepts can create erroneous feelings of racial superiority. In our casteist society these concepts find fertile soil to flourish. The scheduled castes and tribes are, therefore, considered intellectually inferior and incapable of improvement due to their genetic stock.

Of course, our society cannot claim the dubious distinction of being the only one to harbour such ideas. In the U S it is the blacks who are considered intellectually inferior. These, of course, are subjective views. If one were to search for objective answers what would he find? Is intelligence inherited or acquired or both?

However, before one even begins to design experiments for this purpose one would have to define intelligence and devise a unit to measure it. In our country intelligence is usually gauged in terms of excellence in academic performance. Those who top the lists in school, university or public examinations are considered to be highly gifted intellectually. Those who do relatively poorly are thought to be lacking in intelligence.

In the western countries, intelligence tests are employed to arrive at that much valued index of intelligence, the intelligence quotient (IQ). Even these rely heavily on the evaluations of one's ability at mathematical or analytical reasoning and linguistics. Do these really reflect the intellectual calibre of an individual? Because we do say that Kapil Dev bowled intelligently, that Ara has made an intelligent use of colours in his composition. Then there are the international masters of chess. Not all of these men and women—artists, athletes, poets or musicians necessarily possess excellent academic careers. Should they then be considered less intelligent?

These misgivings are being felt by scientists. The inadequacy of the present day assessment of intelligence is now almost universally accepted. And yet there are no alternatives, although a few controversial ones are being seriously discussed.

One of these is the theory of multiple intelligence proposed by Howard Gardner of the Harvard School of Education. After defining intelligence as "a relatively autonomous intellectual competence" he goes on to identify seven types. These are logical mathematical, musical, spatial, linguistic, bodily kinesthetic, interpersonal and intrapersonal intelligence.

It might be argued that some of these like musical or bodily kinesthetic are what are normally termed as skills or talents. That again would be a subjective view since neurophysiological evidence now has established that learning and perfecting these faculties do indeed involve those mental processes generally assumed to be intelligence.

The seven types described by Gardner, therefore, merit consideration if one has to judge whether the presently adopted intelligence tests are adequate and whether IQ is a real measure of one's intelligence.

The linguistic intelligence fully satisfies Gardner's requisite of autonomy as the specific brain mechanism underlying development of proficiency in a language is shown to be localised in a specific area in the left hemisphere of the brain. However, culture and the structure of society to which one belongs influences the form that linguistic intelligence eventually assumes.

Musical intelligence, according to Gardner, is not merely the ability to sing or play an instrument. It involves the capacity to understand the structure of music, being able to break

it down to its constituent notes, play upon them and restructure them into a whole yet uniquely personal composition. If we are to go by the musical prodigies then it would appear that this intelligence is usually acquired at an early age. Although any specific location of the concerned brain function has not yet been identified, acquisition of musical expertise in isolation of other faculties lends support to the concept of its being autonomous.

One of the reasons that logical mathematical intelligence has so dominated intelligence tests is because it is one that is required in most normal day-to-day functions. Ability to reason out is a big asset in daily life when one is faced with a number of situations which need careful reasoning. Although logic and mathematics are usually separately mentioned they are two incarnations of the same basic faculty. Or as Bertrand once opined, "Logic and mathematics differ as boy and man. Logic is the youth of mathematics and mathematics is the manhood of logic." This intelligence continues to awe a layman because abstract mathematical concepts always seem formidable.

Spatial intelligence likewise captures the imagination as it allows one to think and visualise models in three dimensions. That this is autonomous as suggested by Gardner can be borne out by a case cited by Helen Weinreich Haste, a psychologist at the University of Bath. She has reported about an autistic child who had shown extraordinary skill in translating all the visual imagery on paper and yet was constantly a low scorer in the conventional IQ tests.

Bodily kinesthetic intelligence is the most abstract concept of Gardner's, more so because not much neurophysiological or even psychological research in that direction has been conducted. A few studies on olympic athletes are available and the tentative conclusions drawn from these tend to substantiate Gardner's views. However, more concerted investigations on other sportsmen, dancers, mimes

are called for.

To appreciate the two personal intelligences propounded by Gardner one can study teachers, leaders of men, army commanders and counselling therapists. It is often seen that a good teacher is not necessarily the one who has excelled at his own academic performance. Conversely, not all gifted scientists have the ability to impart their knowledge to the students in a cogent and persuasive manner. The same is true for leaders of men or army commanders. Not every one of the latter would qualify as a good field soldier. But in developing a strategy he would be *par excellence*.

Admittedly, Gardner's theory is controversial and speculative. But it has underlined the shortcomings of the present system of determining the intellectual competence. Especially, it has demonstrated that a high score or positive result based on the current system may very well be a correct assessment although the individual should be tested in other departments. On the other hand, a low score or a negative result should not be interpreted as proof of lack of intelligence. Secondly, tests designed to assess intelligence as per Gardner's theory would also fulfil one other criterion, the aptitude of an individual.

Gardner is not the only one to decry the present tests. Others too have arrived at the same conclusion albeit by different routes. A group of black psychologists on the west coast of USA were entrusted with the case of a problematic black school boy Johnny. He couldn't read. His behaviour was atrocious turning on at times to violent. His teachers found him retarded as his IQ was seen to be low. His linguistic score was especially low: he was relegated to the special education classes.

When this group of psychologists started examining Johnny, they didn't find him retarded. His linguistic skills were also normal. What had made him earn a low score in the school IQ test was the use of standard King's English to which Johnny, being raised in a ghetto, was unfamiliar. The group further detected that Johnny was not an exception. Almost all of the black school kids in special education—and there was a statistically high proportion of them—were like Johnny, normal or at times even above normal. They sued the state to rectify the situation.

But they also realised that the battle has to be fought not so much on the legal front as on the academic. The need for devising a more relevant, more realistic intelligence test was very acutely felt.

This prompted a husband and wife team Alan and Nadeen Kaufman to devise a new test now called by the formidable name of Kaufman Assessment Battery for Children (KABC). They claim, that the test judges not what a child knows but how the child knows it. The claim may appear tall but is firmly based on hard neurological facts. It is known that the two halves of the brain control two different kinds of thinking. Sequential orderly thinking takes place in the left hemisphere while simultaneous instant recognition-type thinking occurs in the right. The KABC test depends upon this dichotomy and measures the two modes of thought separately. At the same time it does not ignore completely the strengths of the present system. Thus, the Kaufmans have incorporated the arithmetic and linguistic components in the KABC also.

Like Gardner's theory, the KABC,

too, has its strong proponents and equally emphatic opponents. The latter contend that KABC has the same weakness as the one it is trying to replace.

Controversial though these theories are, they have emphasised the difficulties in finding an unequivocal answer to the basic question that is haunting everyone: Is intelligence inherited? Therefore, the studies that have been carried out using the means available at the moment have to be approached with a degree of circumspection. One such of recent origin is the report of Teasdale of the University of Lund, Sweden and Owen from the Brooklyn College, New York that has appeared in *Nature*.

Taking advantage of the Danish adoption-register, Teasdale and Owen identified four groups of sibling pairs. Three of these groups comprised of genetically related pairs who were adopted and reared apart in separate families. Even these related siblings had differences in the nature of their relatedness. One group consisted of full siblings, while the other was constituted by maternal half siblings. Paternal half siblings formed the third group. To contrast with these three groups, the fourth consisted of genetically unrelated pairs adopted and reared together. Almost all the adoptions had taken place at a median age of five months. The adoptees were also matched for sex, age but not for their ethnic backgrounds. Neither were the adopted homes similar in their cultural status. These four groups were compared with the fifth control group of pairs of full siblings reared together by their biological parents.

On attaining the age of 18, every member of these different groups was subjected to an intelligence test known as the Borge Priem Prove (BPP). Their educational level (EL) as well as medical fitness was examined. Height, which has been shown to be a heritable character, was one of the traits against which the intellectual competence was compared. The assumption underlying this comparison is that if there is a positive correlation between the two traits then intelligence would also be a heritable property. A negative correlation would logically negate the hypothesis.

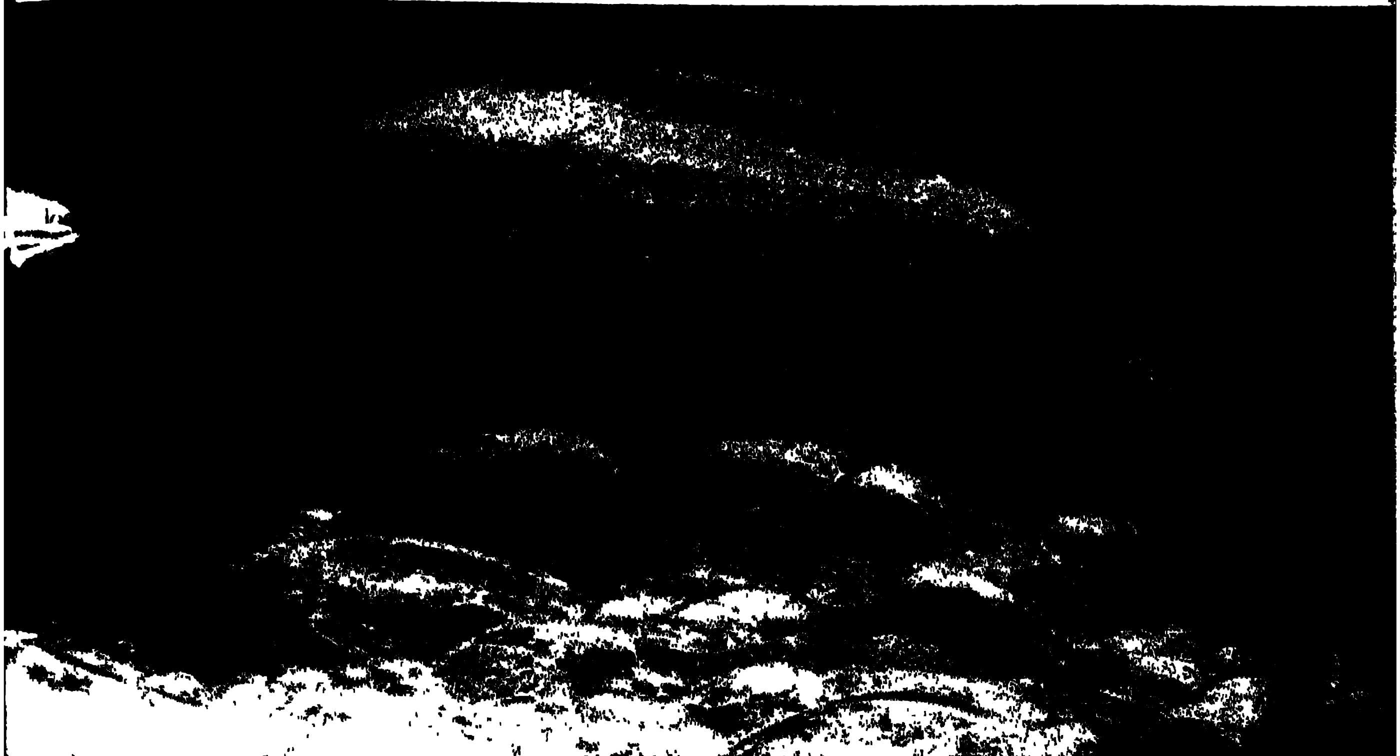
The authors found that intelligence as estimated by BPP supported the hypothesis of a genetic acquisition, whereas educational attainment as reflected in EL appeared to be influenced both by cultural environment and heritability. However, these results should be viewed with caution since height which has been established to be a polygenic trait showed some peculiarities. For example, maternal half siblings showed a better correlation as compared to full siblings whereas paternal siblings did not show any significant genetic influence in their heights.

Partly, the small sample-size in these studies is responsible for these divergent results. The authors freely admit this deficiency in their model which none the less is an improvement on the previous studies. Although Cyril Burt had adopted the model of identical twins his studies have since been discredited. If one were to avoid the pitfalls of his design and his biases that model should provide less ambiguous results. The study of Teasdale and Owen, at least, gives us that confidence. In addition, the tests employed also need to be changed, especially in view of Gardner's hypothesis. Gardner has emphasised the necessity of evaluating cultural influence. But the difficulty lies in dissociating cultural and genetic influences to the exclusion of one from another.

Another facet of the present studies which might have contributed to the paradoxical results is that although care was taken to match the adoptees the families adopting these children were not. Their background, educational attainments and the environment they could provide to the adoptees varied, at times, significantly. This does not belittle these studies in any way but merely underlines the difficulties in finding a clear answer to the question asked.

So we are back to square one. Is intelligence inherited? Possibly. That's the best one can do at the moment. The controversy surrounding this query will, per force, continue and heated debates will take place. The only point of agreement will be that the question would remain unanswered till we can come up with better models, more precise definitions, improved tests and cleaner data. □

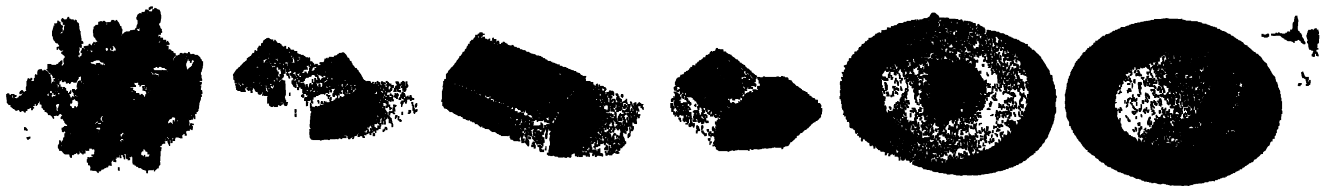
SYNTHETIC DETERGENTS



SYNTHETIC detergents have become an integral part of all households. Housewives, both rural and urban, depend on synthetic detergents for cleaning not only clothes but also utensils, floors, toilets, refrigerators, cooking ranges, etc. Hence we have the 'safest home wash for delicate clothes'; and 'for all things so precious you must clean them yourself', and even detergents which require no scrubbing to remove those stubborn spots'!

The market is literally flooded with liquid and powder detergents, all at competitive prices, leaving the housewife perplexed about what to buy. You might as well ask as to where the soaps have disappeared? Of course, we have our bathing soaps and an occasional bar for washing clothes. But that's all. Don't be surprised if tomorrow you hear about a detergent for bathing too, with it's 'pleasingly perfumed foamy lather'!

[illegible] these detergents? Or [illegible] to mankind [illegible]



Many of them are sulphated or sulphonated substances produced as a by product in petroleum refining But the washing soap—which you are probably forgetting by now -is one of the best detergents! Soap is essentially sodium hydroxide heated with animal fat The mixture is heated for several hours, when soap rises to the surface Upon cooling,it solidifies It is washed, then cut and moulded into bars or cakes Potassium hydroxide is used in place of sodium hydroxide to prepare soft soaps producing fine lather. Soft soaps are commonly used in preparing liquid soaps and shaving creams

Soap is used for cleaning clothes made dirty due to soil particles sticking to the fibres A simple wash in cold water, preferably followed by a hot water rinse should remove these soil particles But usually they stick to the fibres along with oily substances These oils may be body oils, spilled foods, lubricating oils from machinery, or oils vapourised by cooking which settle on clothes Oils are not soluble in water and hence a simple treatment with water will not remove dirt from clothes It is here that the soap comes to our rescue

Soap molecules have a split "persona lity" One end of the molecule is ionic and dissolves in water, the other end is hydro carbon in nature and dissolves in oil When soap is applied to clothes, the hydrocarbon and sticks to oil and the ionic end dissolves in water Thus the dirt particle along with its oily background is removed

But soap is not as efficient in hard water, as it is in soft water where it forms a good lather Hard water has salts of calcium (Ca) and magnesium (Mg) Interaction of the carboxyl groups of soap with these Ca and Mg salts results in the formation of insoluble Ca and Mg soaps which form the scum This makes soap non-available for its cleansing action, which as explained above depends on the water solubility of the soap molecules The synthetic detergents have no carboxyl groups on them and hence they do not interact with Ca and Mg salts of hard water This offers a neat solution to cleansing in hard water

Advent of synthetic detergents

Scientists tried to overcome the inadequacies of soap in two ways The first was to add softeners to hard water The second approach was to develop an entirely new type of cleansing agent synthetic detergent The product developed was like soap in action, but different enough to resist the effects of acids and hard water

The efficiency and behaviour of deter gents are influenced by their structure, the nature of the material to be cleaned, the nature of the dirt, the temperature of the cleansing operation and the pH of the solution Hence each detergent will achieve its optimum efficiency under various conditions

The first synthetic detergent developed was sodium lauryl sulphate It was an expensive, though a popular detergent It was followed by alkyl benzene sulphonate (ABS) prepared cheaply from (tetramer of) propylene, benzene, sulphuric acid and sodium carbonate

This synthetic detergent was an instant success But it brought miseries later on It was found that the branched chain structure of ABS molecules was not readily broken down by micro-organisms in the sewage treatment plants Foam started accumulating in rivers and it appeared in drinking water sources, even the supply of ground water was threatened There was a huge public outcry which led to the banning of ABS detergents

New degradable synthetic detergents soon arrived to take the place of ABS They are called linear alkyl sulphonates (LAS) Though LAS are biodegradable, they lead to the production of phenol which is a toxic material Thus these detergents increase the biochemical oxygen demand of water

In an attempt to constantly improve upon detergents, phosphate salts were then added to boost the effectiveness of synthetic detergents Now too, they form one of the ingredients of detergents But they in their turn of damaging the environment were found to speed up eutrophication (killing animal life by deprivation of oxygen) in lakes The synthetic detergents containing 40 to 60 per cent or more of these phosphates have resulted in pouring thousands of tons of phosphates in lakes and rivers Phosphates also limit the growth of algae in water This fact has compelled its manufacturers to reduce the phosphate content of synthetic detergents

Sodium trinitrilo triacetic acid (NTA) soon replaced phosphates as it was thought to be less dangerous and easily biodegradable However, even NTA was found to be dangerous it caused cancer in experiments on rats and mice, and formed metal-chelating substances with metal ions. These chelating compounds pose many problems in sewage pumps, septic tanks, domestic pipe lines and drains

In late 1960s, most detergents contained enzymes Enzymes break down oils, fats and proteins A sustained sales campaign effectively boosted the sale of these enzyme containing detergents But soon they also came to disrepute Proteolytic enzymes were found to cause haemorrhage in lungs of laboratory animals and skin rashes developed, particularly among the workers in detergent factories Soon these enzymes were found to contain high concentrations of toxic arsenic The last blow to these enzyme based detergents came when it was found that they had no additional advantages over the usual detergents By 1971, these detergents were banned in USA and later in other countries too

Back to soap?

Taking into consideration the hazards of detergents, should we go back to soaps? Soap is made from animal fats (mutton tallow), a renewable source but certainly not everlasting Vegetable oil is now being substituted for animal fats

Synthetic detergents are made from petroleum, a non-renewable source Petroleum has to be distilled, cracked, reformed and reacted with a variety of high temperature and energy-consuming operations to manufacture detergents Thus detergents are expensive while soap is cheaper and ecologically safer

Secondly soap washing requires less quantity of water Detergents require huge quantities of water to wash off the foam

Some questions which immediately come to mind are Is it wise to use detergents when there is an overall scarcity of water in the country? Should detergent manufacturing be banned? Should we go back to soap? To answer these and other related questions, the consumer has to wisely use her judgement and knowledge In areas where water is scarce, detergent use should be dis couraged, in other places soaps should be preferably used, except in situations which demand hard stubborn cleaning In short, a judicious use of soap and detergent is best

R.V. Sovani

Prof. Sovani was till recently with the Homi Bhabha Centre for School Science Education He is also a well known science writer

YES MINISTER

Secretary: *"Ministerji, Are you sure you want to really implement the new Technology Policy?"*

Minister: "I am quite positive The Technology Policy, as announced recently by our dear Prime Ministerji, is the most important document clearly announcing the commitment of our Government to the principle of self-reliance for national development After all, how else can we eradicate poverty from our country and modernise our industry and at the same time boost the morale of our scientists who are keen to see that the technology they have indigenously developed, before rushing to take their foreign assignment, is fully utilised? The political leadership is expected to implement this policy after all, isn't it so Secretaryji?"

Secretary: *"Of course, Ministerji Politically we are committed to it and after all it is expected to contribute significantly to the national 20 Point Programme But "*

Minister: "Right, Secretaryji, Now you are talking 'But' did you say? 'But' I mean do you really ?"

Secretary: *"No! No! No! Ministerji, Don't get me wrong What I really wanted to say is that while we should certainly make a big dent in our economy, reduce the brain drain, improve the balance of payment position and even improve our export potential, but looking at our socio economic condition, with our cultural background, not to forget our past traditions and Gandhian philosophy, I wonder whether we should though we certainly could at the present moment, really take steps which could indicate the Government's intention to shift our policy suddenly, though consistent with our philosophy, and affect our balanced relations with the superpowers "*

Minister: "Now wait a minute, Secretaryji does that mean we should or we should not? We can't do both things at the same time, you know At least not immediately Why don't you say something clearly in plain English?"

Secretary: *"Well you see Ministerji The situation is not all that simple We want to consider "*

Minister: "Stop it I know you don't want to take a clear decision, you bureaucrats always have a way of 'not saying' a thing frankly But we politicians can't take such an attitude, you know After all we are answerable to the people Since whatever we say is likely to be misquoted we have to ensure that we can take back what we had not said in the first instance "

Secretary: *"You have got the point now Ministerji, The Technology Policy Statement is far too important a document to be ignored and we certainly cannot have you misquoted on that, even though your Special Assistant may have told the Press otherwise"*

Minister: "My Special Assistant? Has he been talking to the Press again? But I had clearly told him that if any talking is to be done to the Press, it will be I who will do it and that too after you had cleared the text I knew he would get me into trouble one of these days I should not have succumbed to the pressure in appointing him but you know how it is in politics and when you are so busy inaugurating conferences, laying foundation stones, leading delegations abroad, giving receptions etc etc you do need a Special Assistant, don't you? I tell you Secretaryji, the life of a minister does not give him a free moment to ponder over important issues. "

Secretary: *"Like the Technology Policy Ministerji?"*

Minister: "Oh, yes Thank you for reminding me about our policy commitment to the nation Come to think of it the Technology Policy Statement is a complex document, isn't it? Secretaryji?"

Secretary: *Certainly it is Ministerji, with its balanced dependence on Rural and Urban needs, ensuring a proper mix between mass production and production by masses or is it the other way?"*

Minister: "Whatever it is Secretaryji, I must refer to it in my address at the Women's Parliamentarian Club tonight. After all technology can do a lot for women you know "

Secretary: *Hm Hm. you can be rest assured Ministerji, your speech will certainly create a sensation when it is reported next day Ministerji "*

Minister: "That is exactly what I am worried about You know what happened last time when I referred to the role that the multi nationals can play in strengthening our policy of self reliance? Or for that matter, remember my press conference? The one where I proposed we open a nuclear reactor every month in each of the States to keep pace with my esteemed colleague's efforts at the I & B at setting up TV transmitters I went so far as to make allowance for 'low power' reactors if high power or fast breeders proved a bit difficult "

Secretary *"I missed that Sir, you remember you had sent me to the US to negotiate on that question of deciding the capability of a chemical process developed in one of our national laboratories ?"*

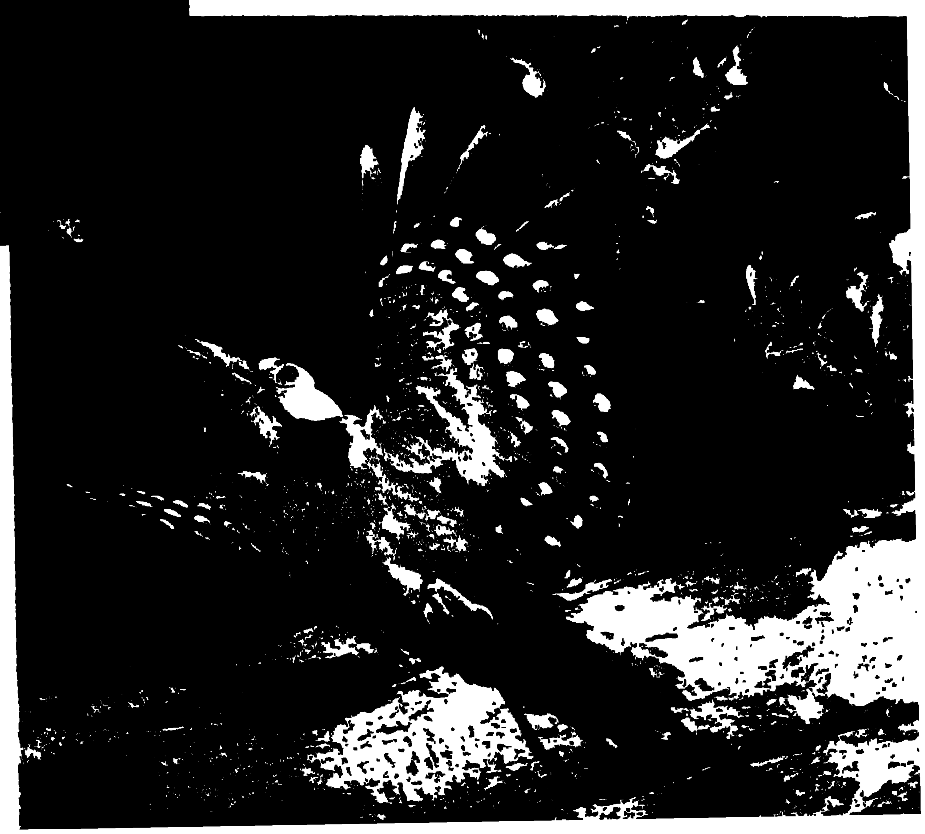
Minister "Never mind that now Don't digress from the reality of the situation I have to give that speech in an hour and I have not even seen it yet "

Secretary *"Don't you worry Ministerji We have already sent a message for their souvenir highlighting the importance of implementing the Technology Policy The speech is essentially the same which you had delivered at the annual function held by the Non Resident Indians who were here to start their new venture on Technology City*

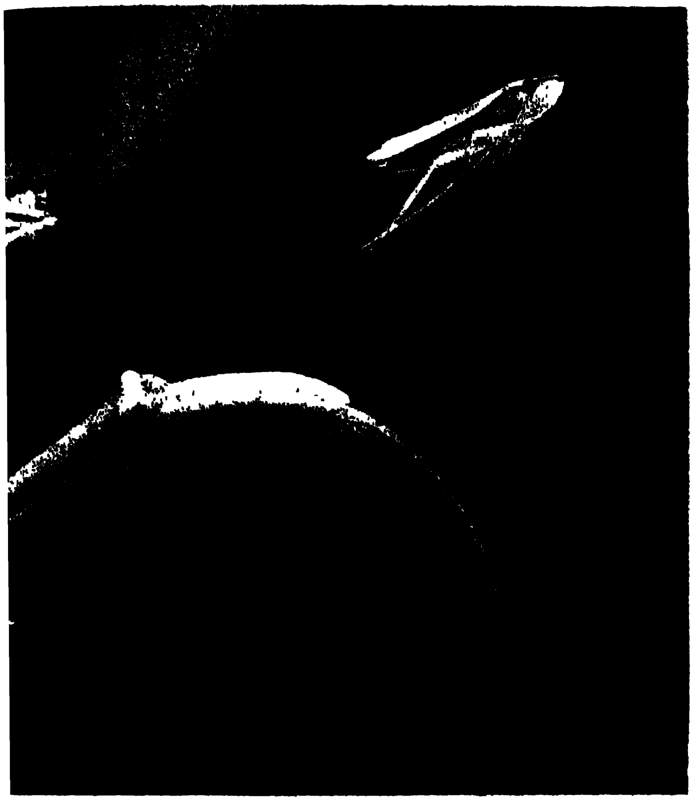
Minister "Oh no let us not start on that topic now "

Secretary *"Yes Ministerji!"*

Prabha Kar



FROZEN MOMENTS



A lot can happen in a split second as can be seen from these astonishing photographs a moth taking off from a bramble head leaves in its wake a shower of scales from its wings, these hang in the air like stardust Water drops bounce off the legs of frogs like mikimoto pearls The photographer, Stephen Dalton who specialises in the capture of split seconds 1 25000th of a second to be precise shares his rich experience in a new book

"Caught in motion—
High Speed Nature Photography"
by Stephen Dalton
Weidenfeld and Nicolson, London,
£ 10-95

Bhabha on
ADMINISTERING SCIENCE

B.M. Udgaonkar

IN a paper prepared for the MIT Centennial Conference on Science and Engineering Education in 1961, Bhabha wrote "I would suggest that a new history of the world, which went deeply into the technological basis of societies, and was interpreted not merely as the result of human decisions, but brought to light some of the physical facts leading to these decisions, and the reasons for the success and failure of these decisions, would be of immense value to us For due to the immense forces put at our disposal by modern science and technology, this generation, perhaps more than any other, has the responsibility of consciously studying itself and its relation to its environment and deciding on the kind of action to take "

"A striking example is provided by the fact that we do not understand why that continuously ascending activity, which we call modern science, should have started a few centuries ago in Western Europe, when there were several other parts of the world, ancient Greece, India and China, in which science and technology had reached just as advanced a stage much earlier than in Western Europe at the time of the commencement of modern scientific development and the industrial revolution "

Then turning to the question of the widening gap between the advanced and the developing countries, he points out (years before *Limits to Growth*) that an exponential growth cannot go on indefinitely it has to saturate into an S shaped curve, and adds, "If this picture of the growth curve is correct, then it has important consequences for our interpretation of the picture of the world we live in It means that *the phenomenon of the 'widening gap'*, whereby the rich or industrialized nations get richer much faster than the poorer or less industrialized ones do, thus widening the gap between the two, is *a passing one* The more industrialized nations will, before the end of this century and possibly within a couple of decades, reach a state of saturation and therefore the gap will narrow again as the presently industrially underdeveloped countries become industrially developed and then reach a state of saturation themselves We may therefore expect to see in the not too distant a future a world in which all its parts are more or less evenly industrialised, with social patterns based on modern technology . ."

Bhabha seems to have been interested in the historical determinants of development and non development of science, from earlier years For, at the opening of the TIFR, he wrote to Prime Minister Nehru, "I have also had the idea that some day the Institute might render useful service to this country by carrying out research in the history of Indian science If the contributions of India and the East to world science are to be systematically investigated and appreciated in their proper historical perspective, it is necessary that a great deal of work on the history of Indian science should be done with the proper modern scientific and critical outlook This is a subject which the Institute might possibly take up at some later stage, if the proper people to do the work can be found "

Administration of science

In an interview, published in the October 1963 issue of *International Science and Technology*, Bhabha was asked 'What is your most serious problem?" and he gave "an answer which may surprise many people—the right administrative set-up Our administration is not adapted to the requirements of the technical age" He concluded the ICSU Address with the following remarks; "It is thought by many that we are reasonably advanced in administration but backward in science and technology This statement is misleading We have fortunately inherited extremely competent administrative services capable of dealing with all the types of administration which had to be dealt with before Independence in what was intended to be a static and underdeveloped economy Consequently, experience of the type of administration needed for industry and for science and technology has been lacking The type of administration required for the growth of science and technology is quite different from the type of administration required for the operation of industrial enterprises, and both of these are again quite different from the type of administration required for such matters as the preservation of law and order, administration of justice, finance, and so on It is my personal view, which is shared by many eminent foreign scientists, that the general absence of the proper administrative set-up for science is a bigger obstacle to the rapid growth of science and technology than the paucity of scientists and technologists, because a majority of the scientists and technologists we have are made less effective through the lack of the right type of administrative support The administration of scientific research and development is an even more subtle matter than the administration of industrial enterprises, and I am convinced that it cannot be done on the basis of borrowed knowledge It must necessarily be done, as in the technologically advanced countries, by scientists and technologists themselves "

In our country the responsibility for the support of science has inevitably remained largely with the Government Bhabha envisaged that this would happen, even as he proposed the founding of TIFR to the Sir Dorabji Tata Trust But even in that letter in 1944, he found it necessary to emphasize that "Financial support from Government need *not*, however, entail Government control", and quoted Prof A V Hill for the British practice where "a buffer of some kind is interposed to prevent Government support from becoming Government control" □

Prof Udgaonkar is with the Theoretical Physics Group, Tata Institute of Fundamental Research Bombay and is editor, Physics News *He was earlier Scientific Adviser to the Planning Commission*

...of the fourth kind

Arun Sadhu

Commander Hemaketu spoke into the channel that linked the reconnoitring space globes: "What are your first impressions?"

"Ahhh what a vulgar planet we have landed ourselves on " came the chorus of voices from the feedback "The humanoid bipeds have highly developed brains, no doubt, but awefully under utilised Social structure is totally distorted and imbalanced Stupid waste of resources, heart-rending inequality Yet, the planet is rich, very rich in resources But the people here seem to be unconcerned with resource management There's one more horror that is unspeakable... is Dnyanamagna there?"

"I am listening " came the reply from the venerable old scientist

"Oh Dnyanamagna, these humanoids kill each other in highly irrational rituals they call war," said the the leader of the survey crafts in a voice choked with emotion "All their science and technology is bent to this evil purpose "

The effect of all this on the Viplavans gathered in the control room was shattering Only Dnyanamagna found his voice "Their nuclear energy? " he whispered

"Yes there's plenty," said the leader, "but they have not developed their wealth and resources from this source of energy We have sent you the details on films and tapes The main purpose of this energy is to destroy life and to create fear "

"By Galaxy !" Dnyanamagna had never so regretted to find this guess proved correct

"By Universe, they are doomed " Hemaketu cried

"Poor creatures They know not they are ignorant," Shandilya sighed

"Don't pity them, Shandilya They are intelligent Therefore they must be perverts to do such stupid things," Vidyasarang said coldly

"Ah what's this " the leader whistled and smiled bitterly "Ever since we went on radio, they have been after us But this is too much I will show you what they are trying to do " The leader pressed a button and the screens in the control room showed a cylindrical object pursuing his globe It was a strange-looking, ponderous device, neither an aircraft nor a flying globe

"This must be their destroyer," Dnyanamagna said "My reading shows that it is packed with nuclear energy," the leader laughed "These people seem to be very adept at manufacturing such things "

"But why is it following you ? Why ?" Hemaketu cried.

Don't know! Monitor other probing globes and you will find similar things tailing them "

"But why? We don't mean any harm to them How foolish they are! If half-a dozen of these stupid things detonate, they will loose their stratosphere and destroy their own planet It's suicide!"

"Well, it seems this is precisely their perversion "

"Stupid, mean creatures," Hemaketu's face was red with anger "I am ashamed to call them human "

"Keep eluding them," Hemaketu said "We shall make a decision in a few moments But don't allow them to detonate That will harm these poor creatures themselves "

The commander turned to the panel of scientists and asked them with exasperation, "How long can we go on playing thus? What are they after?"

Dnyanamagna was scanning a data film in his computer His face turned white with horror

"Mad perverts," he cried in anguish "They do have a propensity for mass suicide, self destruction "

"What's that Dnyanamagna?" Shandilya asked

"Commander Hemaketu," Dnyanamagna said unhappily, " I propose an emergency resolution before the committee Let's recall our probe globes and let's leave this horrific planet immediately "

Shandilya, who was deep in thought, at last said in a calm voice "I understand your revulsion, Vidyasarang and Dnyanamagna In fact, my immediate reaction was similar, leave the planet! Their contact might corrupt us But on second thoughts should we leave these deluded under developed creatures, the only humanoids we have found after centuries of seeking, our brother species, if I may say so, on the brink of extinction? Have pity, Hemaketu They are bipeds, humans They may be foolish But they are humans like us Dnyanamagna, don't forget Don't we have any duty towards our misguided brethren on this beautiful planet? What are we going to tell our people on Viplava when we return? "

Shandilya was warming up and he would have gone on but for an interruption from an emergency signal There was some commotion outside the control room The commander activated the screen and was surprised by what he saw.

In the darkness of the forest, a youthful humanoid was gesticulating frenziedly. He had a flash light in his hand which he was flashing in all directions. He could obviously not see the spaceship. But his actions indicated he knew there was an invisibility shield ahead of him

"By Galaxy," Hemaketu exclaimed "What does he want?"

"Isn't he the same person, the younger one, who came in that flying machine?" said someone

"Can you make out Dnyanamagna? What does he want?" Shandilya inquired.

Dnyanamagna concentrated on the boy's face for some moments, scrutinised his eyes carefully and said, "I think, he has peaceful intentions He wants to communicate with us and wants to be let in "

The young biped was, of course, Parikshit Bhasme

Parikshit did not believe in defeat He *had* to surmount any problem he encountered He was used to them all. Having been brought up in a children's home after being discovered as an infant near a garbage dump it was by the force of his will-power that he had come up. Of course, there was his extra-ordinary mental power, too....

Parikshit was unaffected by the frenzy that followed the sighting of hundreds of those mysterious speeding globes There was a total bedlam on the earth. Hysterical mobs ran aimlessly looking at the sky fearfully Some people stood petrified Others went on to orgiastic binges Nobody knew how many of those strange globes were up in the sky. Even more mysterious was their purpose. As panic spread through the great metropolises of the world, military leaders of super powers contacted each other on hot lines to confirm that earth nations were not involved with the UFO's It was only a formality Because the globes seemed so advanced that it required no special wisdom to grasp that no technology on earth could have produced them Their perfectly spherical shapes, the unimaginable speed, their manoeuvrability, absence of heat emission—everything evoked awe and terror

It was only after the globes broke the radio silence that earthmen acted Half of the air force planes in the world dived in the sky within moments Soon, it became clear that the planes were useless And so, without any consultation, as if by a unanimous reflex, the fatal buttons were pushed, ironically, the nuclear missiles were launched to "save" the earth from the extra-terrestrials!

"We don't want to destroy humanity here. Our Viplavan culture is based on love, intelligence and order. Violence has no place in it"

What followed next was an awesome spectacle never before witnessed on the earth. People stopped running and looked at the sky holding their breath. Some fainted, others shouted in delirium and many were aghast at the implications of what they saw. Not all on the earth could see what was happening. But many did. A globe or two moved about the sky swiftly. Soon a whale shaped giant missile followed probably locked on to its target. The globes would wait teasingly, motionless, in the sky. But before the missile could hit them, they would swiftly turn, change the direction and speed away. These heavy missiles, not as agile and swift as the tiny globes followed thunderously. It was a funny chase, not without grim humour. Like a tipsy fat alcoholic pursuing a playful child. The sluggish missiles would never catch up with the globe, it was obvious. And what if a missile missed a globe and fell on the earth. The world was moving towards a catastrophe. How long would this dreadful chase go on and where would it end? The world waited tremulously.

A stunned Parikshit was brought into the control room. He blinked at the brightly-lit panels and the video screens around him as he was led to a seat opposite the panelists. Kalpaksha placed a garland-like chain round his neck and pressed a button. Suddenly, Parikshit began comprehending what was going about. It was a machine that facilitated telepathic communication. The panelists scrutinised him. Parikshit was confused but not scared. He flashed his eyes curiously around, on the walls, on the screens, at the computers and the faces of the scientists and other crew members. He was tired but euphoric. It was a historic encounter, the first between aliens and earthlings. And what was even more astounding, they were meeting in the fourth dimension, where earth time and space were warped. Of course, the aliens looked just like humans. Except that their skin had a bluish fluorescent tinge, their foreheads were larger, the bodies taller and more slender and they wore strange, unearthly apparel. There was love and goodwill in their eyes. Parikshit knew instantly they meant no harm. He relaxed.

"My friend," Hemaketu began. "Do you understand what I say? We are friends." A strange melodious language. But surprisingly, Parikshit understood. "We are the inhabitants of what you should call the Swastika constellation, 1,500 light years from here. I welcome you on behalf of my people on this great ship."

"On behalf of my earth people, I too welcome you and your people," Parikshit replied hastily.

Hemaketu gestured at the screen and said sadly, "Yes, this seems to be your people's way of welcoming us."

Parikshit's eyes dropped. "They are not people. But anyway, I won't argue. What are you going to do about it? This is horrible. Our planet is in a chaos?"

"Don't be upset my boy," Dnyanamagna whispered. "We can keep it harmlessly for some time. But before that, tell us, how did you know we were here and what do you want?"

"But do something about this sir, fast," Parikshit could not restrain himself. "These are nuclear weapons." Then he remembered Dnyanamagna's question and said, "Distortion of space in fourth dimension. That's why you are invisible to us. Right?"

"By galaxy!" Hemaketu exclaimed.

"How far has this concept been developed here, Parikshit?" asked Shandilya. Apparently, the telepathy machine communicated names and history of the subject also.

"Nothing. Some people may have a vague concept. I don't know. But I had been working on the mathematics. . . . ."

"Remarkable."

"I would like to learn many things from you. But of that later. First tell me how you can save us from doom."

"Your own people are responsible for this situation, Parikshit. You unleashed your barbaric weapons without the courtesy of inquiring." Hemaketu said with a touch of regret.

"We can discuss these issues later, Hemaketu," said Shandilya. "We have to convey our decision to our probe squads. We must also consider Dnyanamagna's proposal immediately. Let's come to the point, Parikshit. We have to decide what is to be done of these killing things. They cannot harm us. But they can certainly destroy you if we take off just now. But we don't want to destroy the humanity here. Our Viplavan culture is based on love, intelligence and order. Violence has no place in it.

"We can freeze them, render them dead and dump them into the sea. But will that straighten the mess your civilisation has made? Tell us, you as representative of the living beings on this planet, what more can we do. You are intelligent and surely you would know how to save your civilisation."

Parikshit was overwhelmed by the responsibility placed on him as the sole representative of the planet. His throat went dry for a few moments. Then he realised that these noble humans were just people. They would not harm the earth. Actually, there was no responsibility on him. He licked his lips and said deferentially. "Shandilya, Dnyanamagna, Hemaketu and the noble people of Viplava. You are just and pious and pure of heart. You know fully well what you should do here. And yet, I would like to make a request. But before that, please, end this game before it becomes too late."

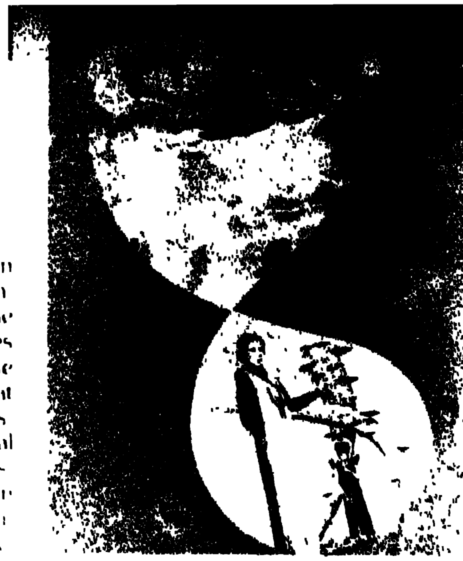
"You are right." Shandilya said. "Hemaketu. Instruct all our probers to freeze those things and hurl them into subspace. Ask them to be careful and not to allow any of those weapons to explode. Now Parikshit, what do you have to say?"

That fateful day is remembered by generations of earthmen. Those strange globes and their swift movements. The terrible fear of the unknown. But as the celestial chase continued for some time, a subtle change occurred in the mood of the people. Though in panic people threw furtive glances at the sky. Soon they could discern a calculated pattern in the movements of the globes. Those extra terrestrial objects were not at all fearsome. On the contrary, they looked shapely, sleek and beautiful. Compared to them, the earthly missiles were disgustingly ugly and vulgar. Their ear splitting din and their fiery aura and what would happen when they ran out of their fuel? Their noses bore nuclear bombs, carriers of death and destruction. It dawned on the people that they ought to fear those ugly missiles and not those transparent globes.

And now the people could also guess the motive behind the playful movements of those globes. It was not difficult for the globes to lead the missiles away and make them hit the earth. But the globes seemed to be conscientiously avoiding such mishaps. These were well intentioned manoeuvres. The people began to admire the globes and hate the missiles.

The next phase of the drama began. A globe circling over London suddenly flashed beams of violet light onto the missile on its tail. The fiery trail of the missile vanished. The globe hauled the weapon away from the city into oblivion. People cheered.

Within minutes the sky was cleared of all those missiles. Silence enveloped the skies. But the globes were still there, undaunted and victorious.



Soon their movements became clear In Washington, two globes stationed themselves about a hundred metres above the White House The two human figures sitting in them were clearly visible The globes sent beams of pleasant light at regular intervals like flashing of eye lids None of the guards at the presidential palace dared to raise their weapons In Moscow the Inner Palace in Beijing Parliament House in London Samsad Bhavan in Delhi Tel Aviv Tokyo Paris Bonn all the world's capitals and all military establishments had globes stationed over them as if keeping a close watch They were motionless and the figures in them too did not move A massive hush fell on the earth People cowered with fear

Parikshit watched the screens with overwhelming relief as Hemaketu and Shandilya monitored the set to ensure that the probe squads followed instructions carefully Then Shandilya turned towards Parikshit,

"Well, there you are Your planet is safe" The telepathy machine worked smoothly

"I know, sir," Parikshit said with anguish "You are angry at our barbaric civilisation and you would prefer to leave this planet soon Is that correct?"

"Immediately Not soon," Kalpaksha corrected

"Really! A great disappointment," Shandilya remarked ruefully "Even the wildest animals on our Viplava resort to violence only when absolutely necessary And I think, even the wild animals on this planet what do you call it Earth? follow this basic principle of nature Only your foolish bipeds seem to have gone astray Vidyasarang I think it will be great education for us if we could pinpoint at what stage of evolution the biped here took this vulgar course"

"Ah And to think we set so many hopes on this planet" Dnyanamagna was disheartened "The only intelligent creature the only biped we came across in our quest of centuries spanning so many stars and galaxies And I cannot even loathe these people After all they are humans But they are doomed suicidal I only pity them"

Shandilya, though crushed with disappointment, kept his head cool

"Let's not make haste," he said "This boy wants to tell us something!"

Parikshit was overcome with shame Never before had he looked at his own civilisation in such a harsh light There was no doubt, it was odius, loathsome and doomed Was there no way out? Couldn't it be saved from destruction Couldn't it be made saner? Who could do that? Who else but these noble people from Viplava, uncorrupted and pure of heart He must speak out

"I can perfectly understand your revulsion," he said

"You are an enlightened one it seems," Shandilya said

"I am not alone believe me" Parikshit's confidence had returned And he felt no inhibition in speaking to these sapient people They would understand him fully

Believe me Shandilya Hemaketu Dnyanamagna There are millions of people on this earth who loathe this inhuman perversities of our civilisation True violence is an inseparable part of our mass psychology But an overwhelming majority of our people are against war, they loathe mass violence they hate inequality and they are against exploitation They believe that with proper management of resources and talents we could transform our planet into a paradise We have organisations which oppose weapons nuclear arms and which fight against inequality and exploitation Please do not carry the impression that all our people approve of this blood thirsty and exploitative social and political system The human beings here are bound in a trap of their own making We can break this trap if an opportunity occurs And I think you noble Viplavans can provide this golden opportunity Shandilya, I appeal to you on behalf of all sane earthmen to help us

"Before you leave this planet grant me a small request"

"Go ahead my boy" Shandilya said his voice heavy with love and piety his smile reassuring "Tell us, whatever is in the best interest of humanity and the entire life on your planet"

The control room was quiet when Parikshit cleared his throat Outside too, a great silence, loaded with expectation, had enveloped the earth

A supernal unearthly voice, divine and celestial It had a sweet male robustness, a resounding dimension of a great waterfall and freshness of a mountain spring The words composed a mysterious music which lifted the heart and soothed the nerves It was a voice of knowledge and understanding, which carried a heavenly melody, full of love and virtue. It was not diluted by the perversities of the earthly noises and sounds There was no trace of greed, no violence in it nor the earthly cruelty which sponsored human inequality It was a pure, unpolluted voice The melodies the earth had never heard, spreading the fragrance of love and piety, understanding and sanity A reassuring voice

The voice rolled over the radio waves and billions of people listened to it in rapt attention with awe The TV screens showed only those stationary globe No human figure spoke

In London, Beijing, Paris, Rome, Taipeh, Lagos, Rio de Janeiro, Havana, New Delhi, Bonn, Stockholm, Manila, Geneva, Cairo, Jakarta, Amsterdam, Tel Aviv everywhere the government leaders heard the voice in fearful silence Hemaketu spoke

"You call it the Swastika constellation in your southern hemisphere Our Sun, Mihir, is the lowermost in it, about 1,500 light years from you It compares well with your Sun and so does our mother planet, Viplava, with your earth

"Friends, for centuries we have been searching for intelligent life in this infinite universe We know the science of space travel, and distance poses no problem for us Our spaceships, which can span space and time with incredible speed, have combed the universe in the quest for life We did encounter many life forms But the first intelligent human civilisation found outside our planetary system is on your earth You can imagine our exhilaration at our discovery Viplavans will rejoice when we return to give them the news Loneliness is not confined to individuals alone, my friends The enormous feeling that they are the only human race in this vast universe is far more poignant and disconcerting than the personal agony of loneliness Your existence, friends, therefore, is reassuring to us Viplavans

"And what we find here when we arrived? We are shocked, friends, I must say What are we going to report when we go back? Our people may not believe us Because they cannot imagine that a human civilisation could be so

"We were aghast at your folly and we decided to return immediately so as to avoid contact with your civilisation"

degenerate, distorted and irresponsible "

"People of the earth, your planet is rich with natural resources, perhaps richer than our Viplava. We feel a deep sorrow that you humans are squandering these resources most irresponsibly and speeding on a suicidal course It is beyond our comprehension that a planet so rich can breed a civilisation so base and mean, based on exploitation, violence and inequality There is something basically wrong with your evolution, friends No life form on any of the planets we encountered was so irreverent of life and nature "

Millions of human hearts on the earth responded to Hemaketu's words with empathy He expressed the grief and desperation of the overwhelming majority of the human race People shouted with joy: "Hemaketu, long live Hemaketu, long live Viplavans...."

"Friends " Hemaketu's musical voice rolled over the radio waves "We came here from 1,500 light years, with a song of love on our lips Perhaps, in this infinite universe, there are thousands of planets like ours harbouring even more advanced civilisations But till we find them, we are the only two human civilisations for company And brothers, how did you welcome us? With your nuclear weapons? Is it a human reaction?

"Weapons bombs, war, bloodshed, mass-killings, murder, treachery these are alien words to us Our screening computers picked them and taught us Their meanings are disturbing Indeed, your civilisation defies the very process of natural evolution where biped human is the ultimate product of the nature Nature creates man to understand itself so that man can soar higher and become one unto nature and comprehend it in its totality And you spite nature . "

Hemaketu breathed deeply, his exhalation carried by radio waves to the earthmen like a fresh whiff of air from the distant stars The people too sighed

"Friends " Hemaketu continued, "and note that we still call you friends Your resources are so rich that your planet can sustain ten times your present population comfortably Use your talents and resources wisely

"We were aghast at your folly and we had decided to return immediately so as to avoid contact with your civilisation And you unleashed your destructive weaponry on us Ah what petty pride ignorant arrogance and vain glory "

There was an edge of anger and contempt to Hemaketu's words It made the military leaders and statesmen of the earth tremble with fear. What will these mighty aliens do? Revenge? Retribution?

"Hear . hear .", spontaneous shouts rose from anti-nuclear groups on the streets "Teach them a lesson, show them "

"For us, your mighty weapons are petty little things, absolutely harmless We could easily have turned them on you to destroy you But our civilisation abhors violence and destruction "

The anger had vanished and Hemaketu was cool again "We are leaving you now, disillusioned and shocked, to report to our mother planet A depressing task But before we go, we shall like to teach you a lesson, to correct things to the extent we can

Was the last sentence a warning? Was the earth doomed? Many fainted at these words But no, these aliens are noble And didn't they say they did not believe in violence?

Hemaketu continued, "It's dangerous to keep nuclear weapons in your hands It might endanger the entire universe some day We know, you still have plenty of stocks Our probing globes stationed above the major cities, seats of your governments and military installations, have all the data ready The weapons still remaining in your irresponsible hands can destroy this planet many times over

The voice abruptly stopped and a deathly silence prevailed on earth for some moments Immediately, the crowds broke in to shout slogans "Zindabad zindabad Viplavans zindabad " " "Down with nuclear vampires "

The mood was volatile The rulers had no option Even before they could make formal decisions, the military personnel had begun throwing their caps and ribbons and leaving the installations Submarines surfaced to let out life boats, continuous alert planes flying in the sky began landing hastily, armies of life boats sprang around the warships •

Exactly in an hour, the stately globes unleashed their silent fireworks The globes trained their red, violet and white light beams on military and nuclear installations, on warships and nuclear silos to destroy them noiselessly and harmlessly It was a vastly reassuring sight which made humanity heave a collective sigh of relief

THE dark night was full of stars The sky above was busy with action General Fernandes and Pamela watched the sky for a good part of an hour and then Pamela stood up "Now, General, We must go "

By the time, Pamela, Fernandes and their two guards reached the edge of the forest, the bright planet of Venus on the eastern horizon had dimmed and there was a faint suggestion of a pink dawn beyond the trees But down in the jungle, it was still dark General Fernandes flashed his light into the thick forest and cried excitedly

"It's gone, Pamy the forest is as it was It knows the alignment of trees Didn't I tell you Pamy, that boy is a genius... "

Pamela brightened They set out again more confidently flashing the lights The air was cool and refreshing The pink sky was now visible in patches from the jungle

"There it is the plain Ah how beautiful "

General Fernandes ran ahead Pamy and the guards followed The open grassland glowed in the faint pink and violet hue of the early morning The dew drops sparkled like mellow pearls on the grass blades A strange but soothing fragrance pervaded the atmosphere And at the centre of the oval shaped ground a small dark figure was discernible

"Parikshit, " Fernandes shouted and began running in spite of his age

Exactly at the centre, a broad column of earth, about a metre tall, jutted out of the ground with narrow groves over it Parikshit slept blissfully against it He had a sweetly patterned multi coloured blazer on him, a strange thing the like of which neither Pamela nor Fernandes had ever seen Another strange object was a spherical box, made of an unknown metal, synthetic or otherwise, which emanated a strange but pleasing combination of melodies never heard

"Parikshit, my boy you are safe " Pamela hugged him warmly

"You are simply great, boy " General Fernandes patted him on the back trying to fight back his tears The guards stood smilingly

"You need not have taken the trouble, aunty It's so chilly here " Parikshit said with embarrassment

General Fernandes looked at the spherical box with curiosity Parikshit lifted it casually

"A baby computer with Viplavan music, a present from Hemaketu"

"Ah, Viplava " The old couple exclaimed in unison with awe and reverence

—Concluded

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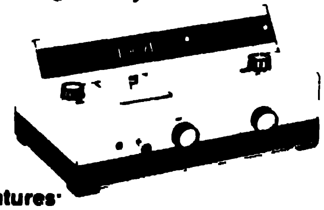

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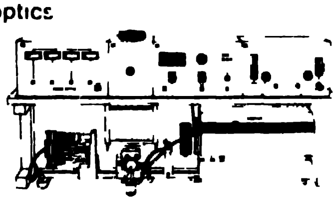

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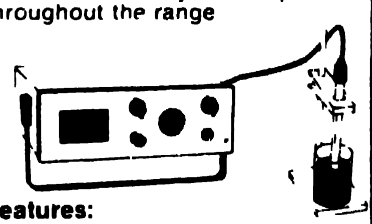

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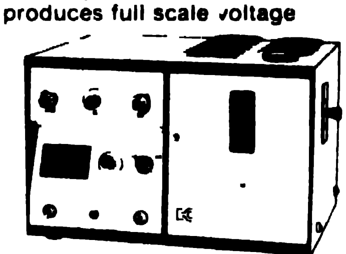

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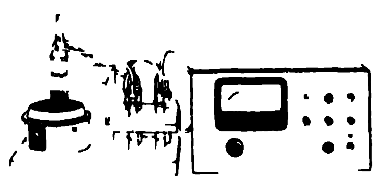

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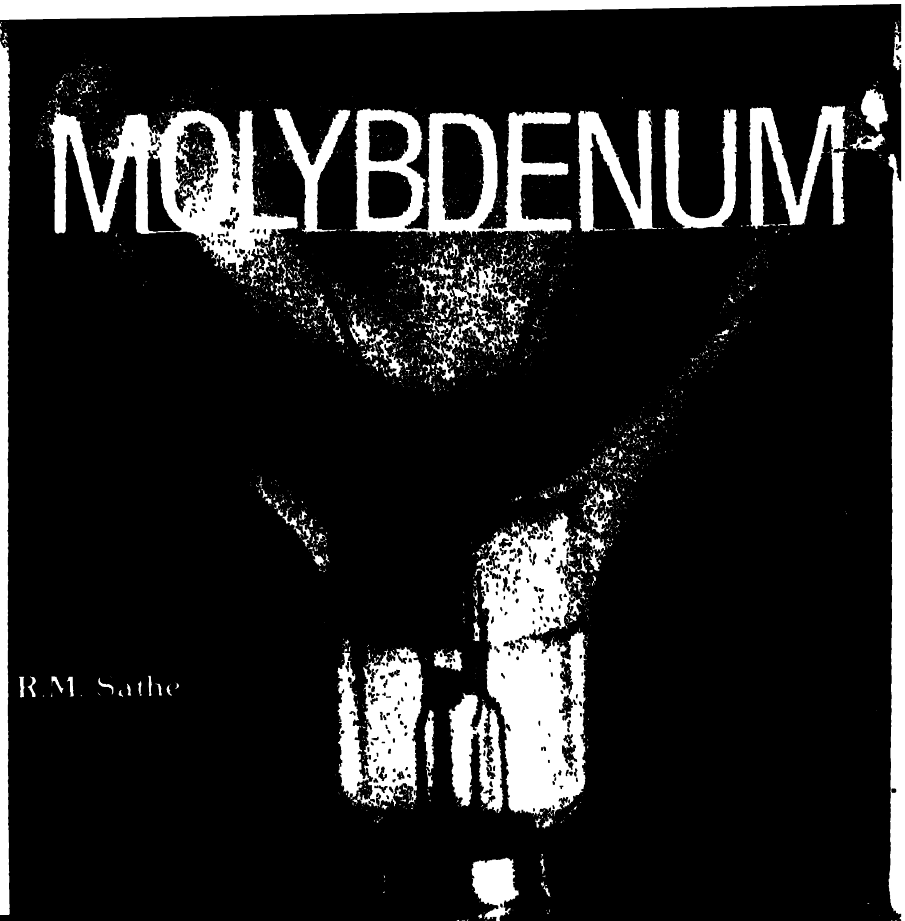
Resources for tomorrow

MOLYBDENUM THE SAINTLY METAL



R.M. Sathe

Tukaram, the saint poet of Maharashtra, describes the likes of him as "servants of God, softer than wax but also harder than the hardest of Indra's thunder bolts, at the time of need" Molybdenum fills the bill appropriately Its addition to steel makes the latter super hard while its compound with sulphur serves as an ultrasoft all weather lubricant Further, it is so humble and unpretentious that hundreds of its flakes piled one over the other will only manage to form a modest stack, one micron (0 0001 cm) thick As if this is not sufficient, traces of this metal play an important role in sustaining life by helping soil bacteria in the process of nitrogen fixation and protein synthesis Probably, that is why this saint among metals is so scarce Its abundance in the earth's crust is only 0 0003 per cent

The element

The element was discovered by the Swedish chemist Scheele in 1778 and named molybdenum after the Greek word *molybdos* (meaning lead) because of the close resemblance of its mineral molybdenite with the lead mineral galenite Like lead it can be used to write and draw it leaves a greenish grey trace on paper Even today *molybdos* in Greek means a pencil A few years later in 1783 his colleague Hjelm succeeded in extracting the metal in powder form largely contaminated by its carbide It took more than hundred years before it could be obtained in pure form The first molybdenum filament was produced in 1907 For many years, the metal could not be subjected to any mechanical treatment because of its brittleness It was later realised that the brittleness was caused by the presence of traces of oxygen or nitrogen But when obtained in pure form, it was found to be fairly ductile and extremely hard as well

Production

The most common ore is the sulphide molybdenite MoS The largest and richest deposits occur at Climax Colorado in the USA accounting for about 70 per cent of the free world production Canada and Chile are other important free world sources In the USSR, large deposits were discovered in 1934 in the North Caucasus

The ores generally contain relatively small amounts of moly sulphide They are concentrated by the froth floatation process and roasted to give crude molybdenum trioxide The action of aqueous ammonia converts it to ammonium molybdate which on subsequent heating yields the pure oxide The oxide is further reduced by hydrogen to produce the metal in powder form The powder is converted to the massive state by powder metallurgical technique Here, the powder is compressed hydraulically in dies at 30000 to 40000 psi and is heated electrically at 2200 2300°C in an atmosphere of hydrogen

Till the beginning of this century, the metal had practically no demand and the production was only 10 tons in 1900, but it suddenly went up by about 50 times during the First World War Most of us are familiar with the story of atomic energy during the Second World War European scientists who had emigrated to the U S feared that Germany was on the verge of making a devastating weapon based on nuclear fission Their fears later proved unfounded but gave enough impetus for USA to produce the atom bomb and subsequently, harness this energy for peaceful purposes

A similar situation occured during the First World War The French positions were being mercilessly pounded by German artillery composed of the Big Bertha a 98 ton howitzer named after the obese wife of its maker, Gustav Krupp von Bohlen Allied intelligence received reports that the Krupps were using moly steel for the Big Bertha gun barrels This prompted USA to move fast for developing sources and researching effects of alloying steel with molybdenum The intelligence reports were subsequently found to be untrue but the impetus for molybdenum utilisation was amply provided The production of the metal rose sharply during the second World War and, by 1943, reached 30,000 tons It would, thus be very tempting to designate molybdenum simply as a "martial" metal!

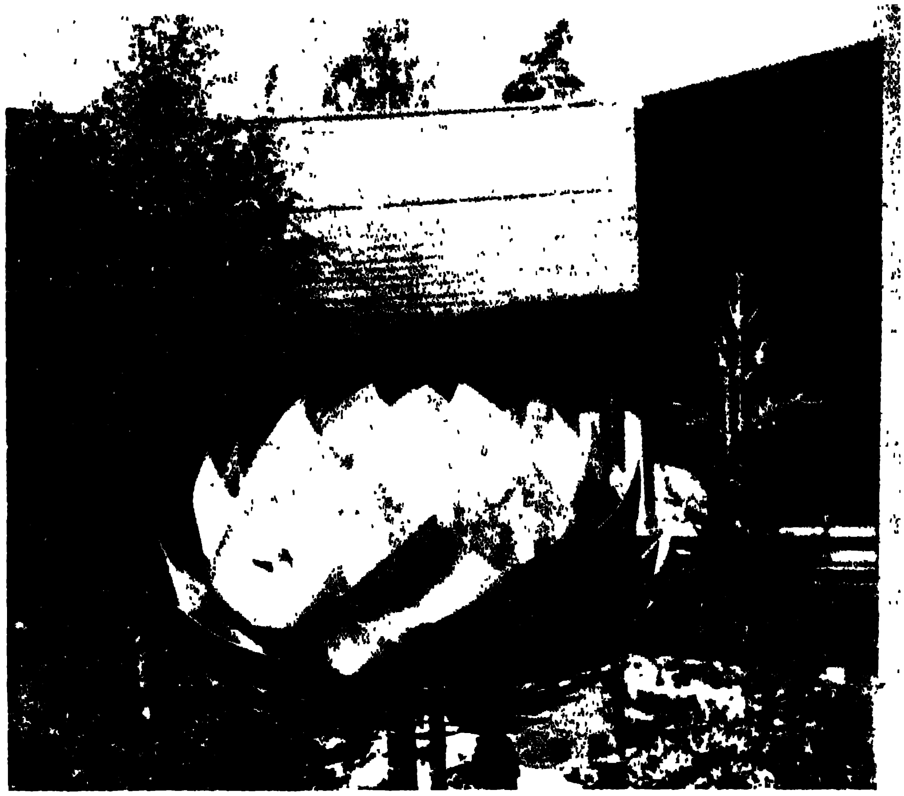
The metal

The metal is highly refractory It melts at 2610°C and its (estimated) boiling point is 5560°C It is not affected by oxygen at ordinary temperatures but combines with it readily at higher temperatures (>600°C) to form the trioxide A protective thin coating of $MoSi_2$, however, confers outstanding resistance to oxidation even upto 1650°C Because of its permanent

silver white lustre, the metal can successfully imitate the king of metals, platinum In jewellery it can be a reliable substitute for platinum because of its ease of workability and significantly lower cost Molybdenum wire can replace platinum for winding electrical resistance furnaces where the heating is quicker and temperature attained much higher (~ 2200°C) Owing to high melting point and low expansion coefficient, it is widely used in electron and X ray tubes and for making filament holders in common electric lamps

Compounds

The most important compound is obviously molybdenum sulphide with its outstanding lubricating properties It owes its lubricity to a graphite type layered lattice in which the repeating unit is a sandwich structure consisting of a hexagonal sheet of sulphur atoms The forces between these sandwich layers are relatively weak so that cleavage and shear between adjacent laminae are



Molybdenum is soft as a petal yet hard as steel

extremely easy It can be utilised as a dry film lubricant or added to greases or oils in suspension to improve their lubricating properties It is stable under a variety of environmental conditions and is ideally suited for space applications Certain critical components of the vehicle that landed the first man on the Moon in 1969 were lubricated by molysulphide

The applications of molybdenum compounds have increased substantially over the last fifteen years in a number of new areas They include catalysis (for conversion of coal to gasoline), protective coatings, inhibitive pigments and flame or smoke retardants

The solution chemistry

The chemistry of molybdenum is probably the most complicated of all the elements The reason for this is three fold (i) the element can exist in a number of oxidation states the most common being III, IV, V and VI, (ii) the most common ion in alkaline medium is MoO_4^{2-} but on slight acidification, it undergoes extensive polymerisation One of the important polymeric species is the paramolybdate ion and its ammonium salt $(NH_4)_6Mo_7O_{24}\cdot 4H_2O$ The mechanism of polymerisation is similar to the conversion of the chromate ion to dichromate in an acid medium except that the latter process does not proceed beyond the dimerisation stage, (iii) in addition to these isopolymolybdates, it readily forms heteropolymolybdates in the presence of other oxyanions like PO_4^{3-} and SiO_4^{4-} As many as 35 elements are known to take part in heteropolyanion formation The heteropolymolybdates have immense analytical importance The yellow precipitate of ammonium phosphomolybdate is commonly used for qualitative identification and quantitative estimation of phosphorus Many of these, on selective reduction exhibit intense blue colours and form the basis for the colourimetric estimation of traces of the heteroatoms (e g silicon) Some of the heteropolymolybdates are also potential candidates for ion exchange separations Such inorganic ion exchangers are better suited for radioactive environment, where the commonly used organic exchangers suffer radiation and high temperature degradation

Molysteel

The pride of place in the market of modern civilisation undoubtedly goes to steel The per capita production of steel is a sure indicator of a country's progress and prosperity It assures a nation's victory in war and plenty in peace The history of modern Europe was shaped not so much by its politicians as by steelmakers like Krupps and Vickers A noted historian has ascribed the success of Rama not to the justness of his cause but to the sharpness of his steel tipped arrows! In its efforts to

From the sea

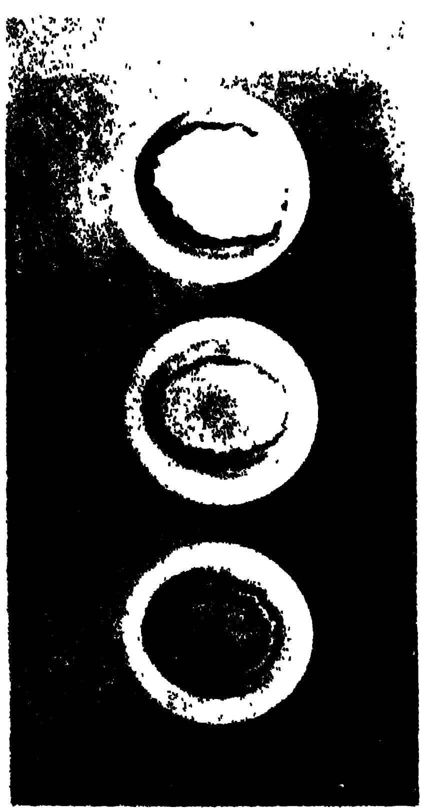
OUR reserves of molybdenum in the earth's crust are meagre and with rapidly increasing demand would soon get exhausted. But that would not be the end. There are distinct bright rays of hope. Our seas and oceans contain enormous reserves of many metals and molybdenum is one of them. Sea water contains about 10-15 ug of molybdenum per litre. If successfully tapped, this source would amount to about 100 tons per capita!

Trace quantities of molybdenum, say in the sea water, can be estimated by extractive photometry. The common method is to extract the orange red Mo (V) thiocynate complex into a suitable organic solvent and determine the Mo content colourimetrically. A more sensitive and selective method is to measure the electron spin resonance signal of the extract. Mo (V) has a single unpaired 4d electron. When placed in a strong magnetic field it can absorb microwave radiation of appropriate [illegible] to change its spin state. [illegible] of the absorption [illegible] measure of the molyb[illegible] concentration. Amounts as [illegible] (ng/ml) can be [illegible] (Fig. 1).

improve its qualities and enhance its utility, steel has picked up numerous allies and made many friends They are, to name a few, manganese, nickel, chromium and tungsten Molybdenum has been a recent and highly beneficial addition to this list So much so that service to steel as a valuable alloying element has remained its primary and principal task Practically 90 per cent of molybdenum produced in the world is consumed for this purpose by the special steel industry

The main advantage is the extreme hardness it can impart to steel without in any way increasing its brittleness Moly steel (a favourite short form used by metallurgists) is therefore ideally suited for armour plates During the first world war, the first British and French tanks made from hard but brittle manganese steel were easily destroyed by enemy shells A two per cent addition of molybdenum brought about a dramatic change The tanks became impregnable even though their plates were reduced to one third of their original thickness Tungsten which closely resembles molybdenum both in its chemical and physical properties can bring about a similar highly desirable transformation But tungsten is costlier and a three-fold excess would be needed to achieve the same effect (see box on page 71) These steels are also characterised by considerable strength at elevated temperatures and high creep resistance Some of the ultra-strength compositions have yielded strength as high as 2100 Newtons per sq mm Hence apart from armour plate its use extends from gun barrels, aircraft and automobile parts, turbines and cutting tools to cutlery and razor blades Over 90 per cent of all hacksaws and twist drills in USA are now manufactured from moly-steel The extra ordinary sharpness of the swords used by the Samurai--fierce warriors of yore in Japan has been ascribed to the presence of molybdenum in their steel It would be of interest to examine the Bhavani sword of Shivaji for its molybdenum content!

Another important application of moly steel is in cryogenics In low temperature environments, ordinary steel becomes fragile as glass Special cold-resistant steel containing chromium was found to be unsuitable because of the cracking of its welds Addition of 20 per cent molybdenum enables the welds to withstand temperatures as low as $-200°C$


A

B

C

Fig. 2

Analytical kit

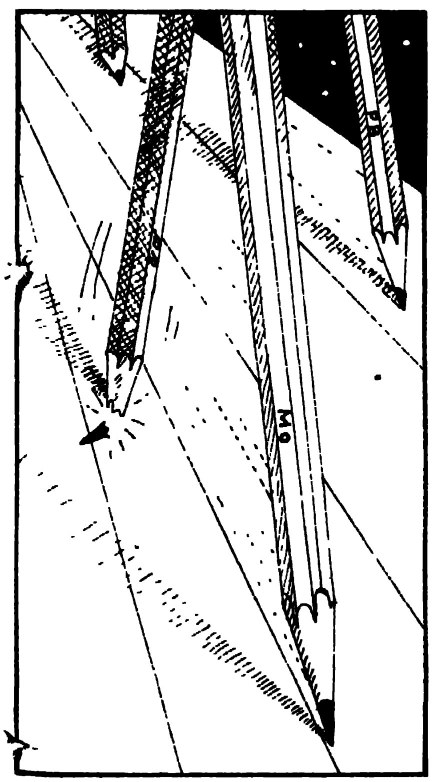
THE Analytical Chemistry Division of BARC has developed a compact and portable field kit for rapid and nondestructive identification of molybdenum containing steels (Fig. 2)

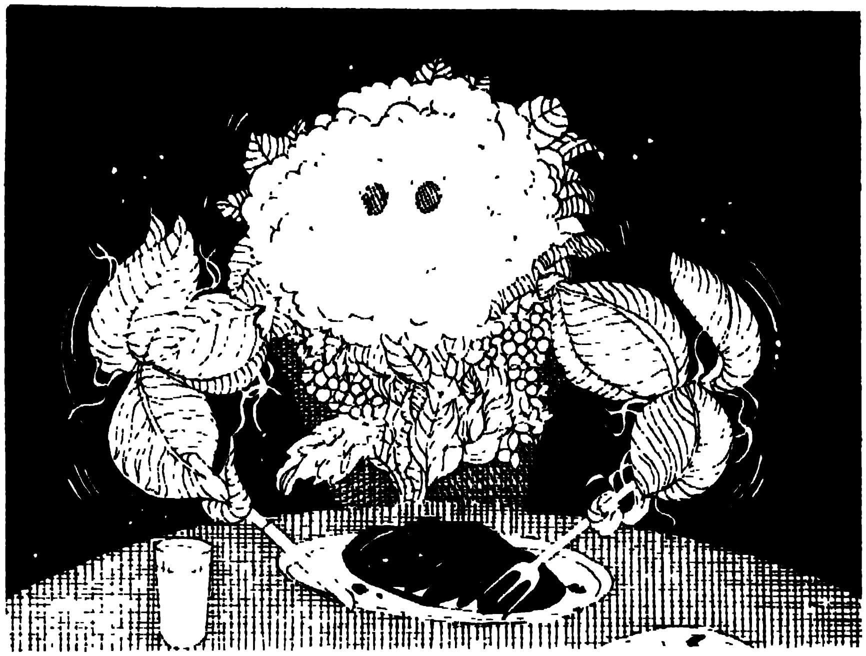
A filter paper moistened with solution (A) is interposed between the steel sample piece and an aluminium disc and electrolysed for half a minute with a 9 0 V battery A yellow spot appears on the paper Successive additions of solutions (B) and (C) produces within three minutes a pink coloured circular band if the steel sample contains molybdenum. Comparison of the tint with the band contained from a standard molysteel will give a semiquantitative estimation. The kit is being patented.

Chemical twins

THE Chemical properties of elements are mostly governed by the size and valency of their atoms. If the valency is identical, the increase in atomic size, as one goes down any group-say from lithium to cesium—is sufficient to differentiate their chemical properties and lead to simple methods of separation An exceptional situation occurs for some elements of the same group due to the intervention of the lanthanide series The so called 'lanthanide contraction' brings about a decrease in size as one goes from lanthanum to lutetium The subsequent elements therefore, possess practically the same size as the elements of the same group preceeding this series The 'twins' of identical size and valency so produced are zirconium-hafnium, niobium-tantalum and molybdennum tungsten The 'twins' possess similar chemistry, often pose formidable problems in their isolation from one another

Molybdenum leaves a greenish grey trace on paper





Molybdenum in trace quantities promotes healthy growth in plants

Daughter extraordinary

Molybdenum 99 is a product of uranium fission This radioactive isotope gives birth to an extraordinary and ephemeral daughter product Technetium 99 an entirely new element which does not exist in Nature Tc 99m is a low energy gamma emitter with a short half life of 6 0 hours and can be repeatedly 'milked' from the parent Mo 99 by solvent extraction or chromatographic procedures Compounds labelled with Tc 99m serve as radiopharmaceuticals which are extensively used as diagnostic tools for imaging brain lesions and scanning body organs like liver, kidney etc for detecting any changes in their shape or size

Molybdenum in life processes

Traces of molybdenum are found normally in all plant and animal tissues The element along with copper zinc and others is regarded as one of the essential micronutrients for their function in the metalloenzymes or as enzymatic activators Its presence in the diet increases the activity of an essential enzyme called xanthine oxidase In plants it is necessary for bacterial fixing of atmospheric nitrogen Molybdenum deficient soils respond dramatically to spray application of sodium molybdate by enhancing the yields of many crops and improving their breed The yields of peas cauliflower or tomatoes can also be increased by about 30 per cent by treating the seeds with ammonium molybdate

It has been established that presence of a certain element in human hair determines its colour as happens in coloured glasses Nickel makes hair fair titanium imparts a golden hue while molybdenum makes them flaming red

At present the only source is a low grade molysulphide concentrate (about 80 tons as molybdenum), available from a by product recovery plant of the Uranium Corporation of India Ltd situated at Jaduguda in Bihar The concentrate also contain sulphides of copper nickel and iron Because of the hold back action of these impurities, the conventional route involving roasting and vacuum distillation is unsuitable for obtaining good recoveries of the trioxide of satisfactory purity Development work for an alternate route was carried out in the Extractive Metallurgy Section of BARC Two processes based on hydrometallurgy and molten salt electrolysis have been extensively studied In the former the molysulphide is organised by hypochlorite in alkaline medium to give sodium molybdate which can then be converted to pure trioxide

In the electrolytic process molybdenum metal in good recoveries can be obtained by used KCl K MoCl as the fused electrolyte and the sulphide or carbide as soluble anodes. The "know how" generated in BARC is being transferred to MIDHANI (Misra Dhatu Nigam) for commercial production The output is expected to fully satisfy the country's modest requirements which are at present exclusively met by import of molybdenum powder □

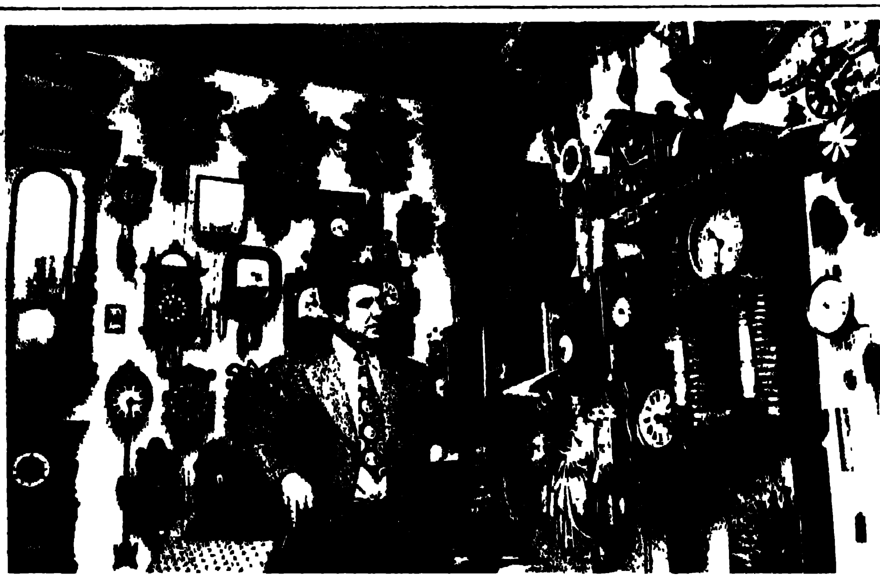
Dr Sathe is with the Analytical Chemistry Division at the Bhabha Atomic Research Centre Bombay

The Answers:

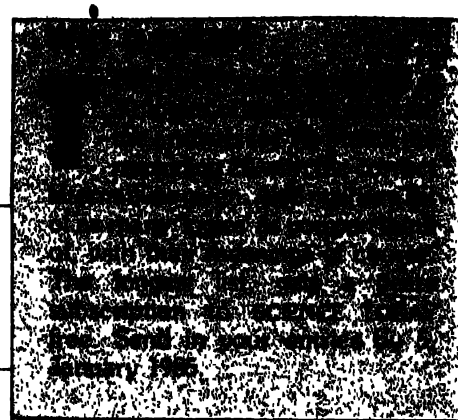
Continued from page 33

1. Tocology—A The term tocology refers to the science of childbirth Used in obstetrics, this word is derived from the Greek *tokos* meaning birth and *logos* meaning science It includes within its scope, natural childbirth, and medically induced childbirth

2. Deontology- A The science of duty or morality or ethics is often referred to as deontology Deontology or deontological ethics has its roots in the Greek word *deon* or duty It is a theory of morals that defends "duty for duty's sake" or corollaries like, "virtue is it's own reward" Deontological theories have been called formalistic, because their central principle lies in the conformity of the action to some rule or law In the classical age, the Stoics were the main deontologists They believed that moral wisdom consists in living "according to nature" Judaism and Christianity are also viewed as formalistic since they emphasise on the duty of obedience to God's will The chief formalist of modern times was Immanuel Kant, the 18th century German founder of critical philosophy Another is W D Ross, a British philosopher



3. Harology—A The art of making clocks and measuring time, is referred to as harology This word is a synthesis of the Greek *hora* or time and *logos* or telling The first device for indicating time was probably the gnomon, a vertical stick or pillar, the length of the shadow of which indicated the time of day Gnomons date from about 3,500 B C In about 300 B C, the hemispherical sundial or hemicycle was made by the Babylonian astronomer Berosus Later water clocks were invented by the Egyptians and were improved upon by the Greeks who called them clepsydras In around the first century A D sand glasses came into existence followed by hour glasses, lamp and candle clocks The origin of mechanical clocks is obscure, but the first portable time pieces came into existence in the 16th century. Since then, harology has developed at a rapid rate, electrical watches, electronic watches and atomic clocks are some of the most modern innovations in harology



4. Entomology—B: Is the scientific study of insects, the largest single class of the animal kingdom The *Insecta* comprises 850,000 known species. Unlike most other areas of biology, entomology may be divided into many sub-disciplines for example, taxonomy, ecology, behavioural physiology etc Most branches of the science have applied and non applied aspects The latter relates to the many insects that have no known economic importance Applied entomology on the other hand, studies insects that are pests to crops, forests, or other resources, or carry diseases of man or livestock

5. Sitology—C Sitology, or the science of regulation of diet, falls within the scope of dietetics Dietetics is concerned with menu planning and the provision of detailed advice about food and special diets for both individuals and institutions Dietitians have professional training with emphasis on dietary treatment of the sick

6. Demonology—B: The word devil is derived from the Greek *diabolos*, meaning slanderer or accuser. Demonology encompasses all literature available on demonic spirits. The devil as the great power of evil has been depicted in both secular and religious art. Demonology, satanism and witchcraft are represented in many ancient cultures, western as well as eastern.

7. Ornithology C The scientific study of birds, ornithology, had its beginnings in prehistoric times Most of the early writings on birds are more anecdotal than scientific, but they represent a broad foundation of knowledge, including much folklore, on which later work was based In the Middle Ages, many treatises dealt with the practical aspects of ornithology, particularly falconry and game-bird management In the 18th and 19th centuries, the trend in ornithology was towards the description and classification of new species In the latter half of the 19th century, efforts were devoted to the study of the internal anatomy of birds In the 20th century, more emphasis has been placed on the ecology, ethology (the study of behaviour) and the functional adaptations of birds Ornithology is one of the few scientific fields in which non professionals make substantial contributions

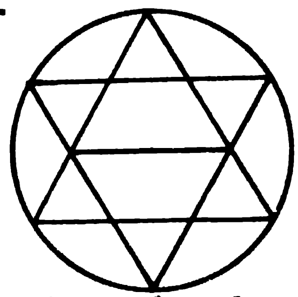
9. Penology—B: The study of prison management, also known as penology, concerns methods of handling convicted criminals. Prisons came into widespread use only in the last 300 years. Penal systems everywhere remain largely based on tradition, untested assumptions and inferences derived from inadequate data. The types of prisons in use in the world today are very diverse and consequently so is penology.

8. Pathology—B: Pathology is a medical speciality concerned with the essential nature of a disease, especially the structural and functional changes in the cells, tissues, and organs, caused by disease. Pathology is an important tool in medical diagnosis. Tests are done on blood, urine, cerebrospinal fluid, faeces, sputum, gastric contents, semen and abnormal fluids obtained from the chest, the pericardium (the sac enclosing the heart) or the peritoneal (abdominal) cavity. Hair, nails and skin scrappings are also tested.

10. Neurology B The word neurology is derived from the Greek word *neuron* meaning "nerve cell" It is a complex branch of anatomy, dealing with the study of the brain, nerve cells, spinal cord

BRAIN TEASER

SINGLE-CIRUIT FIGURE



CAN you draw the adjoining figure without lifting the pencil from the paper and without retracing a line?

(Solution next month)

A.R. Rao

Mr Rao is with the Vikram A Sarabhai Community Science Centre Navrangpura, Ahmedabad

Solution to September teaser

Let us first find out Suresh's type Suppose Suresh is type Y, then correct answer to his question is 'Yes' which would mean both Suresh and Sumitra are both type N This would mean Suresh is type N, which contradicts the assumption Hence Suresh cannot be type Y He must be type N Since he is type N, the correct answer to his question is 'No', so it is not the case that he and Sumitra are both of type N This means Sumitra must be type Y

Our congrulations to Swapnajit Mittra and Rukmini Mitra, Calcutta; C S. Nayak, Chitradurga, Raminder Singh, Varanasi, M Giridhar, Salem; Vidhyut R Basak, Jamshedpur; Jaideep Kalgutkar, Bombay; Louie M. Varghese, Bhilai; Sharmistha Mazumder, Salt Lake City, Calcutta; H.B. Kantawala, Baroda, and Chirag S. Mehta, Manipal, Karnataka, who have sent in the correct solution to our brain teaser in the September 1984 issue.

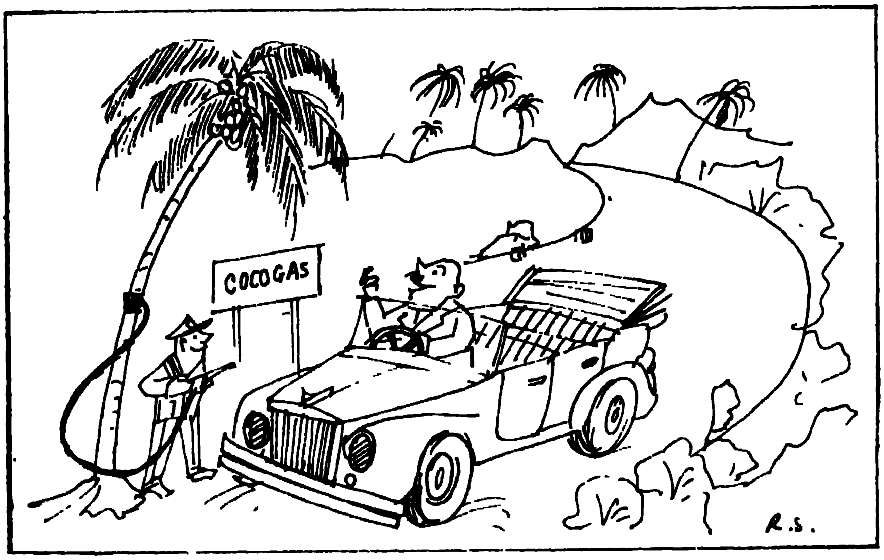
Editor

CAN COCONUT OIL SUBSTITUTE DIESEL?

A nation wide programme of using a blend of five per cent crude coconut oil with 95 per cent diesel oil in diesel engines was started in the Philippines in 1982 to see how far this can help to diversify from petroleum products In these proportions, the specifications of the blend hardly differ from those of pure diesel fuel Also, this was the right quantity to consume the surplus coconut oil of 120,000 metric tonnes per year

After about two months of the programme, operational difficulties appeared when complaints of fuel filter clogging were received from some bus operators A coco diesel task force was formed to look into the problem Investigations revealed that a gelatinous substance which appeared its growth are within easy reach The growth, however, can spread to the entire volume of fuel in the tank if all the water absorbed during the day does not condense out as the fuel cools There was evidence that this, in fact, happened with the free fatty acid in the crude coconut oil allowing water to remain in suspension with the fuel If the coconut oil is initially highly contaminated with microbes, then the presence of these three elements—water, fungus and fuel—could result in serious fungal growth throughout the fuel in the storage tank

After this experience, a type of semi-refined coconut oil called "cochin oil" was used for the experiment In this, the free fatty acid content of the oil was kept to less



to be a form of micro organic growth was causing the problem

Examination of the storage tanks, from which coconut oil diesel fuel was supplied to the complaining bus operators, indicated a build up of this gelatinous substance in the bottom of the tanks This was analysed to be a combination of normal diesel sludge and accumulated dirt as well as fungal and bacterial growths It appeared that the presence of water at the bottom of the tanks was providing a good environment for microbial growth

As fuel warms during the day, it absorbs water from the air, only to condense out of the solution when the fuel cools at night Thus, water pockets are formed below the fuel in the storage tanks Fungus grows best at the interface between the fuel and water because food and water needed for than 0 05 per cent compared with crude coconut oil which is typically more than two per cent

In April 1983, a six-month monitoring programme for the cochin oil diesel blend was started with an initial purchase of 125 metric tonnes of cochin oil blended to a 5/95 fuel mix This fuel was supplied to a fleet of 168 passenger buses of the Manila Metropolitan T ansit Corporation

After six months it was found that there were changes in the percentages of free fatty acid, protein and moisture in the storage tanks, but these changes were not significant enough to cause fuel deterioration No perceptible differences were noted in microbial counts Fungi predominated over bacteria and yeasts after 10 months of monitoring No major microbial deposits were observed in random samples of fuel filters The frequency of filter changes remained normal

Thus the Philippine experience has shown that coconut oil is a feasible diesel fuel extender In its crude natural form, a blend of diesel fuel with as much as 30 per cent coconut oil can be used to run diesel engines for extended periods of time as indicated by the prolonged fleet tests and endurance tests

A potentially serious problem, however, emerged in the bulk handling, trans shipment and storage of coconut oil diesel blends Microbial growth and slimy materials that clogged fuel filters were attributed to the use of crude coconut oil highly contaminated with fungi, bacteria and yeasts Multiplication of these microbes was enhanced by the presence of water in the fuel

The use of a semi refined coconut oil, with less free fatty acid, a lower moisture content and a lower microbial load, apparently controlled the problem Intensive microbiological monitoring at various points in the handling, storage and tran shipment system helped to control the growth

Crash-resistant boxes for export

Long-distance dispatch of fruits and vegetables is often a source of worry for exporters Substandard packing often causes damage leading to substantial losses. The Thailand Institute of Scientific and Technological Research (TISTR) has designed a crash-resistant packing box, made of hard corrugated boards, to overcome the problem.

The newly designed boxes have been found to withstand 700 kg weight for fruits and 400 kg weight for vegetables. Vent holes provided in the box allow air circulation in transit and thus reduce chances of fruits and vegetables getting spoilt due to humidity and heat, a common occurrence with conventional packing boxes

According to TISTR authorities, these boxes would drastically reduce the present 30 per cent damage of the goods (in Thailand) in transit. These are expected to replace the conventional wooden and bamboo crates totally in the near future.

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FINISH	100	50	95	96	93
SURFACE	98	92	67	91	93

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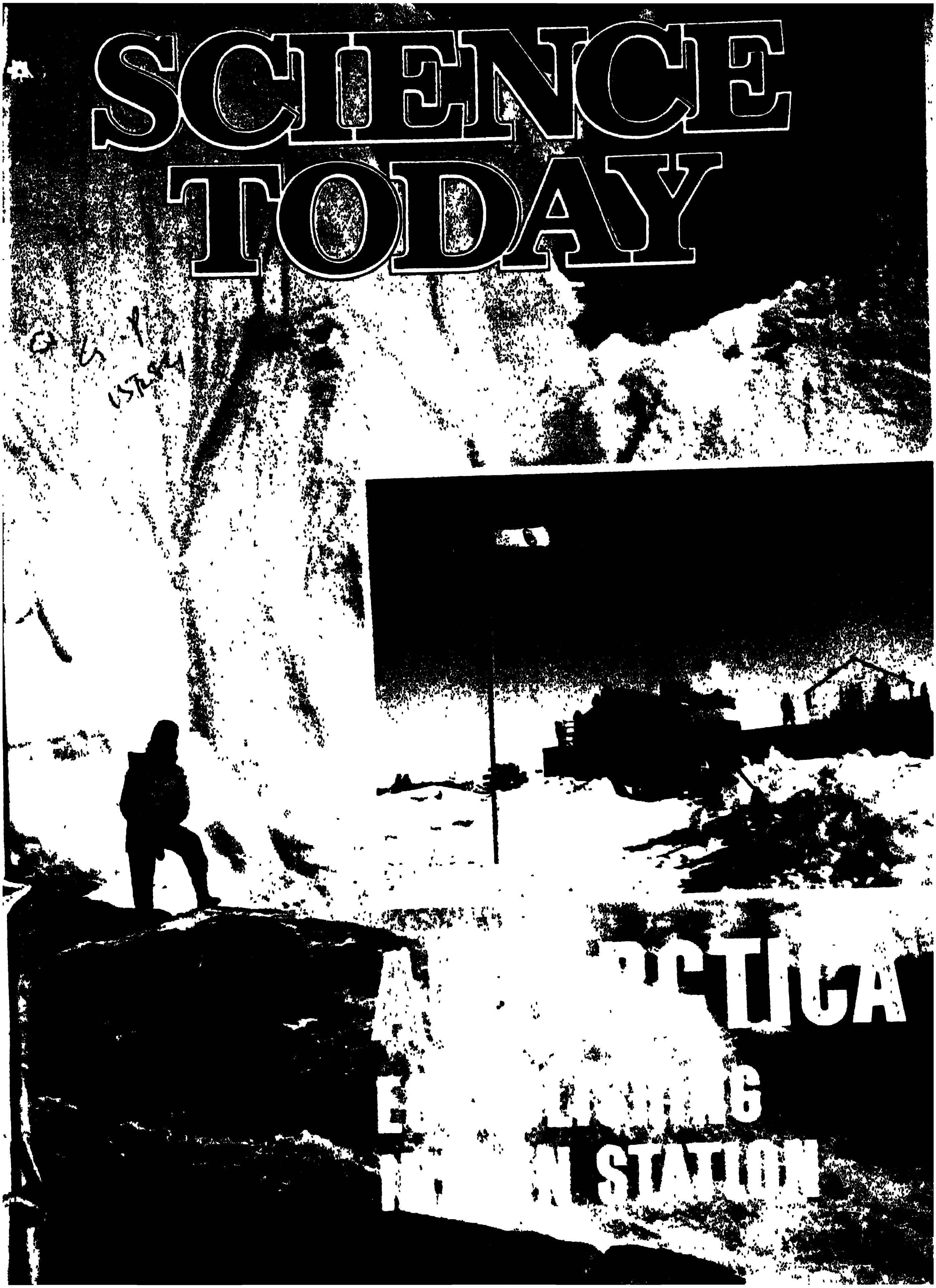
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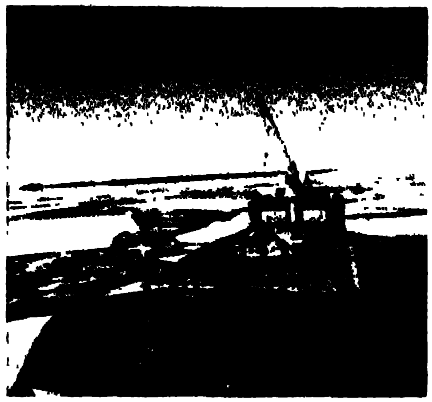


Cover designed by Ramesh Sanzgiri

Queen of Indian Science

At the control room of Tarapur Atomic Power Station with Dr. Vikram Sarabhai

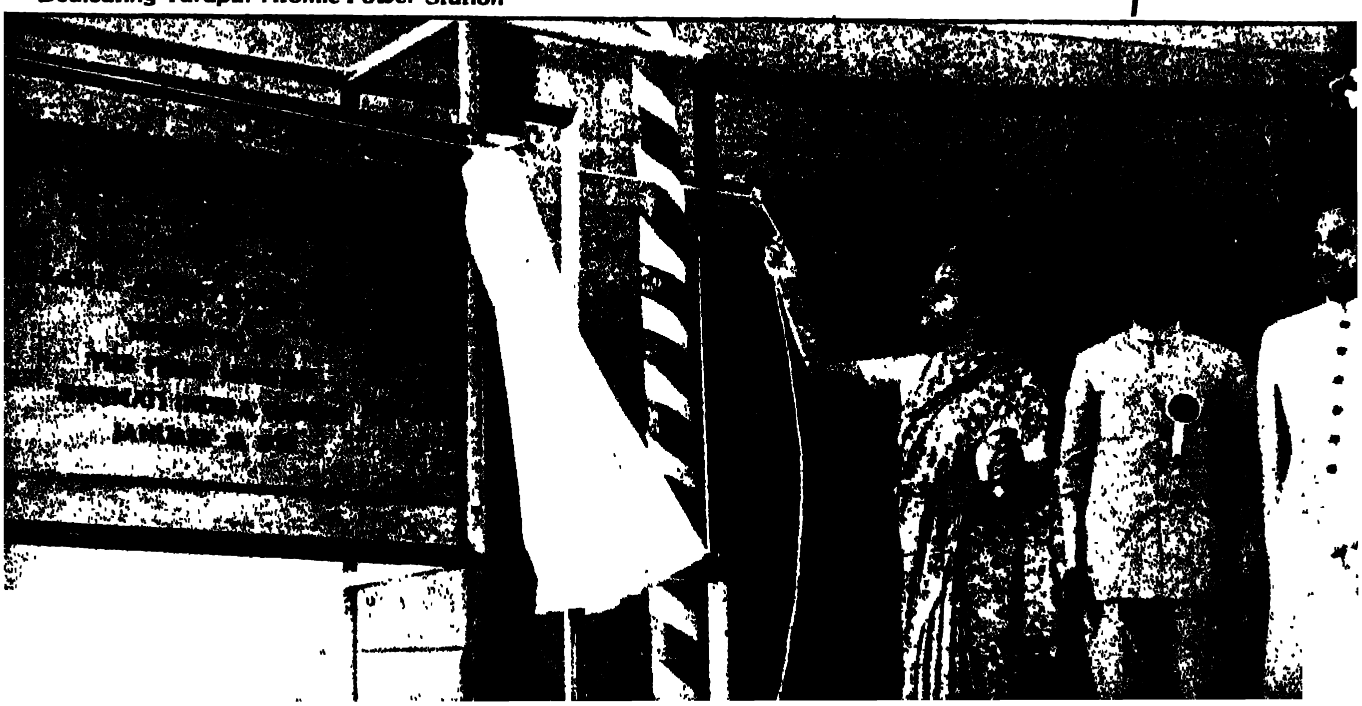
Inaugurating the 69th Indian Science Congress

"Science can and must cement society around a new set of values. The search for truth and the verification of evidence are major values of science. A true scientist is always ready to discard even a lifetime's work, when a new fact which negates his assumptions is discovered But the constant reexamination of beliefs is not amongst the virtues of people at large, here or elsewhere In our country, some are too prone to act on hearsay or out of intolerance Agitations in defence of superstitions or unfounded reports are not unknown Democracy is based on the assumption that the other person could be as right as oneself Our scientists should not hesitate to shoulder the responsibility of promoting a temper of tolerance and respect for facts"

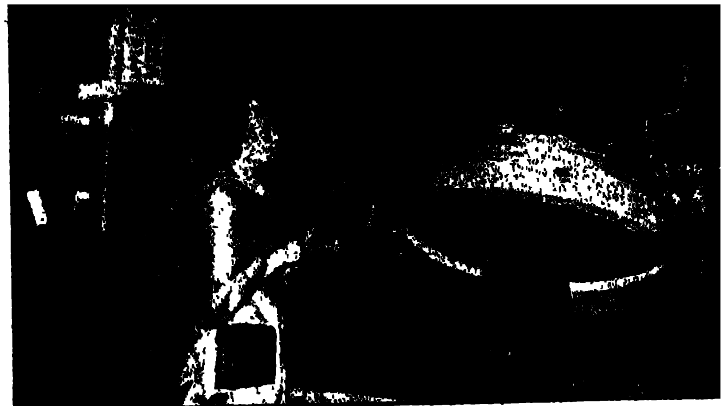
Speech on 3rd January 1971

Indira Gandhi

Dedicating Tarapur Atomic Power Station



isiting Delhi Earth Station with Prof. Yash Pal

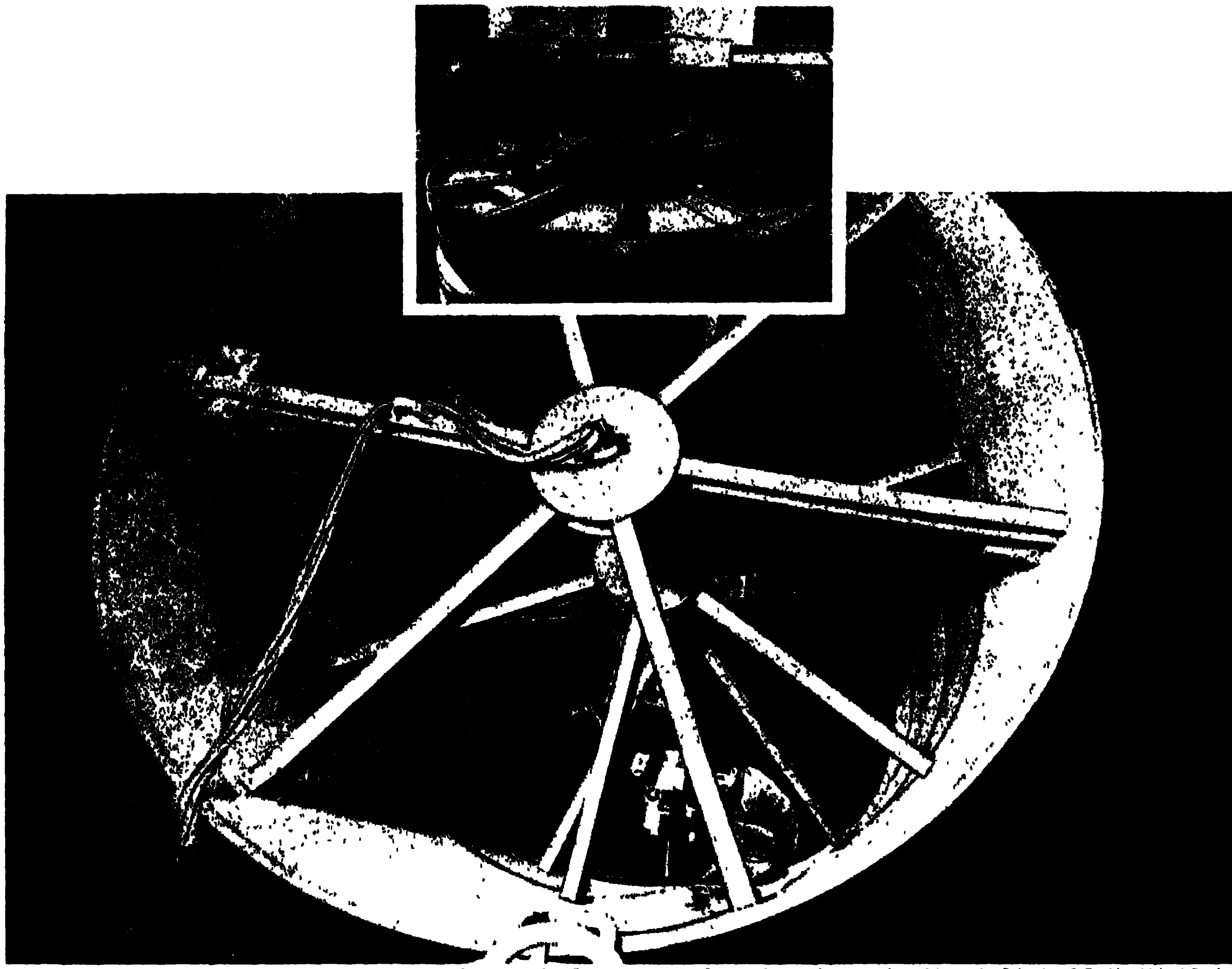


Watching the model of "Apple"

At Pokhran

reeting members of First Scientific Expedition to Antarctica with Dr. S. Z. Qasim

Only Advani-Oerlikon turns tubular wire, ingenuity and agglomerated flux into Fluxocord-40



Inset A vital stage of production of our flux cored wires Main Picture A light end fractionatur being fabricated at Richardson & Cruddas, Mulund, Bombay

Fluxocord-40 meets the sub-zero temperature impact requirements of critical submerged-arc welding applications.

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Even as one was hoping that the curtain will be brought down on Orwellian year of 1984 without any of its cynical and pessimistic prophesies coming true, disaster struck in the form of a gruesome assassination of Mrs. Indira Gandhi. In her death, Indian science and technology have lost their most ardent supporter and patron. That this should have happened at a time when our scientists and technologists had brought the country close to being self-sufficient in food supplies and were making sizable contributions towards fulfilling her dream of making India strong and prosperous, is 'the most unkindest cut of all'.

Ever since Independence, the ministries of Atomic Energy as well as Science and Technology have been presided over by the Prime Minister. Jawaharlal Nehru had taken charge of these departments out of his personal conviction that only a scientific approach can pave the way for a modern and thriving India. On assuming the office of the Prime Minister in 1966, Mrs. Gandhi might have bowed to tradition and retained these ministries in her personal charge. But she certainly had inherited her father's love and respect for science and technology. For, during her tenure both the departments not only received active support and encouragement but a sense of purpose and direction. She was responsible for instilling in our scientists and technologists confidence and self-respect.

This is reflected in a series of significant achievements during her time in office and especially during the last few years. The indigenous development of tracking equipment for our naval ships which led to the sinking of 'Gazi' during the

> **"We have advanced greatly in science— I am a greater believer in science—and the scientific approach has changed the world completely."**
>
> **— Jawaharlal Nehru**

Bangladesh War is now well-documented. So is the peaceful nuclear experiment conducted at Pokhran in 1974 which brought home the understanding that with the right type of encouragement and nurturing our scientists are equal to the task and also to their counterparts in other parts of the world.

Nehru would rightly be considered as the father-figure of Atomic Energy. He promoted the spread of scientific temperament. Building on this, Mrs. Gandhi took Indian science and technology far beyond its geographical boundaries, literally from the depths of the ocean to the vast expanses of space. It was during her tenure that the departments of Space and Ocean Development came into independent existence. Our country was admitted as a member of the Antarctic treaty and a permanent station was established on the frozen continent. The impact of her leadership would have been greater had she been fortunate like her father, to have as her associates men of the stature of Bhabha and Bhatnagar. It was also during these last decades that a number of technocrats started assuming the office of Secretary in a number of important government departments. She was already seized of the problem arising out of a large number of our scientists and technocrats leaving our shores for greener pastures abroad. She had full faith in the ability of our scientists and had expressed it in no uncertain terms during her brief speech at BARC barely three weeks before her tragic death. Truly, the loss to the Indian scientific community is irreparable.

EDITOR

SCIENCE TODAY

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FULL-FAT SOYFLOUR

The article 'Soybean' (September, 1984) by Dr Y P Gupta is informative and analytical However, commercial soy products like *Nutrela, Mealmaker, Nutri Nugget, Protein Plus, Protesnac, Paushti kahar, Soy Panjeeri*, etc available in the market are expensive and conform basically to a limited pattern of utilisation suited to higher income groups They are not within the reach of a common man who mostly suffers from the protein calorie mal nutrition Hence, there is a greater need to develop simple and adoptable techniques of utilising soybean in rural and urban homes using the available domestic tools and kitchen gadgets/utensils One such technology has been developed at the Central Institute of Agricultural Engineering, Bhopal, for using soybean in the form of full fat soyflour

The method consists of cleaning, splitting of soybean into soydhal, soaking soydhal in water containing 1% sodium bicarbonate at room temperature for four hours, boiling the soaked dhal in water for 15 to 20 minutes, drying the soaked and boiled dhal and milling it into flour The soy-flour thus produced contains about 40% protein and 20% oil, and is devoid of all anti-nutritional factors and off-flavours It can be stored for a period of three months in an air tight metal container or plastic bags without any deterioration in quality The flour can be blended with cereal/pulse millet at 10 to 15% level to make a wide range of traditional recipes such as *pakoda, bajjia, sev, puri, chapati, halwa, burfi, mysore pak*, soy-peanut crisp, etc By introducing soyflour in our diets, the protein energy mal nutrition can be combated

NAWAB ALI
A P GANDHI

Post Harvest Technology Schemes
Central Institute of Agricultural Engg
Nabi Bagh, Berasia Road, Bhopal 462 018

Announcements

The Society for Advancement of Electrochemical Science and Technology, (SAEST), Karaikudi will be organising the Third International Symposium on Advances in Electrochemical Science and Technology for five days from 10th to 14th December, 1984 at Madras The symposium will concentrate on the latest advances in electrochemical science and technology, and also the scope of the future possibilities It is also proposed to conduct an exhibition displaying the latest techniques, products, instruments and equipments

Those electrochemical industries who wish to register themselves as co-sponsors and also for participating may contact Dr V Krishnan, Secretary, Society for Advancement of Electrochemical Science and Technology, C/o, Central Electro chemical Research Institute, Karaikudi 623 006

The Environment Mutagen Society of India (EMSI) will be holding its tenth annual conference at Bhabha Atomic Research Centre, Bombay from 18 to 21, February, 1985 The theme of the conference will be 'Environmental Mutagens and Human Health Problems and Perspectives' Besides the five symposia topics related to the above theme, the conference will hold a one day programme devoted to plenary lectures of popular nature on topics like genetic diseases cancer (epidemiology), environmental mutagens and carcinogens, and occupational and industrial health Those interested may contact Dr M S Chaddha, Chairman, Organising Committee, 10th Annual Conference of EMSI c/o Bio Medical Group, Bhabha Atomic Research Centre, Bombay-400 085

Ice-cream in space

In your September 1984 issue you have reproduced my correspondence with Anjali and also included a number of colourful illustrations One aspect has come out wrong in the illustrations In my original letter to Anjali, the intermediate stage in melting an ice cream bar was an oblong and not hollow doughnut• Since my drawings were hand-drawn, probably your artist mistook the figures to be doughnuts rather than just slowly rounding blobs

YASH PAL

Secretary
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We regret that an inadvertent error was committed in the visual translation of Prof Yash Pal's thoughts

Editor

Those printer's devils

In answers to 'The Name Game' (Scientifically Speaking, July, 1984) under *Nelumbo nucifera*, a photograph of *Nymphaea* and not of *Nelumbo* is shown *Nymphaea*, commonly called as water lily, has much narrower petals than those of *Nelumbo* *Nelumbo* has almost ovoid petals

NANDAN T. KALBAG

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An important mistake has crept in the article (Immobilised enzymes, June, 1980) while mentioning the name of the enzyme present in goat's stomach The enzyme has been printed as renin which is a different enzyme in that context and is concerned in the prevention of sodium loss by the kidneys The enzyme's name with reference to the above article should have been rennin It is also called a milk curdling enzyme

K S NAGARAJ

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B K Hostel
Sheshadri Road
Bangalore 9

An error has crept into an otherwise informative article ("Potable water—within our reach", June 1984) where the author mention in para one that viral hepatitis B which has claimed over 300 victims recently in Gujarat, is due to poor sanitary conditions and bacterial contamination of water Such characteristics are attributable to viral hepatisis A (HAV) and Non-A Non-B hepatitis Viral hepatitis B is spread through blood transfusions, blood products, surgical instruments and needles and syringes contaminated by HBV virus It can also be transmitted through mosquitoes, saliva, semen, etc HBV does not spread through water or food

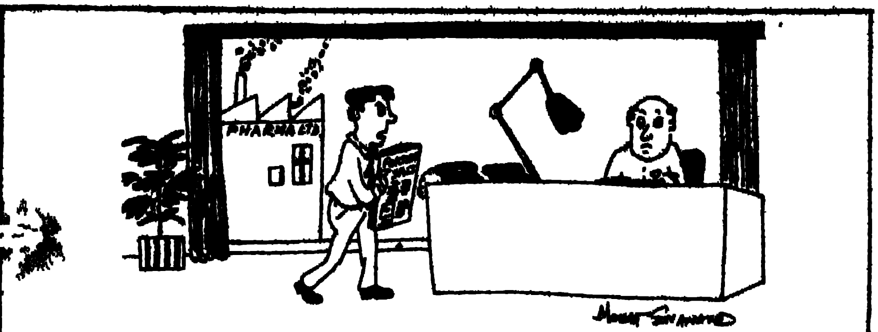
V SURESH

Air Force Hospital Kalaikunda
Kharagpur 721 303

The venue of the National Symposium on Vacuum Technology and Sealed Devices from 19 to 21 December, 1984 is the Institute of Engineers Hall, Bangalore and not at the Bhabha Atomic Research Centre, Bombay

We regret the above errors

Editor



"Darned fortified salt! It's messed up the sales of our Biberol Forte."

Fortified salt and anaemia

THE National Institute of Nutrition (NIN) at Hyderabad has come up with a practical and cheap formula to fight iron deficiency anaemia (IDA) in the country It has recommended the use of iron fortified common salt (IFS) for the entire population And the Government of India is taking steps to launch a national anaemia control programme with this IFS

More than half of the rural population and large sections of the urban population suffer from anaemia and women are the major sufferers Poor and inadequate diet are known to be the major factors aggravating anaemia To fight this widespread scourge, NIN scientists reasoned that salt is an effective vehicle for supplementing dietary iron Since it is manufactured at only a few places in the country, salt fortification could also be carried out on a countrywise basis

Iron, in the form of ferrous sulphate (which is easily absorbed by the body tissues) was the choice of NIN scientists Though ferrous sulphate alters the white colour of common salt, NIN has succeeded in producing a com pound which remains stable for eight months without change of colour or deterioration in quality The new compound consists of 3.5 mg of orthophosphoric acid (which prevents colour change) and 5 mg of sodium acid sulphate (improves iron absorption) in each gram of powdered salt

Two longterm community studies carried out by NIN have successfully demonstrated the effectiveness of IFS in preventing and controlling anaemia Though the sceptics caution against the widespread use of IFS—extra iron intake might increase the risk of infections – NIN scientists confidently claim that "IFS consumption by normal people is safe and that, on the contrary, the available evidence shows that extra iron may actually improve immune status and other functional capacities of the population"

Goitre, an iodine deficiency disorder, is also widespread in the Indo Gangetic belt (where anaemia severity is high), and to fight it the Government is supplying iodised salt in endemic areas Now NIN hopes to fortify common salt with both iron and iodine to fight goitre and anaemia simultaneously

Plastic wrapping for babies

A PLASTIC bubble film normally used to protect fragile goods also acts like a light duvet, or continental quilt, and keeps babies warm and protected from draughts This has been found by doctors at the intensive care unit of the Queen Mother's Hospital, Glasgow, Scotland

The plastic material is warm, light and cheap and, because it is transparent we can see what happens to the baby The wrapping is popular. It is being manufactured in sterile conditions The lives of premature babies are now being saved in a Scottish maternity hospital because of this new use of an industrial wrapping material.

Should boxing be banned?

ALL those tumultous years in the boxing ring seem to have at last caught up with Muhammad Ali—three-time winner of the heavy weight championship. Ali who could once "float like a butterfly and sting like a bee" is believed to be suffering from symptoms similar to Parkinson's disease —slurred speech, loss of co-ordination, reduced muscle strength and a persistent feeling of fatigue This has raised the inevitable question, should boxing be banned? Is there a connection between Ali's condition and career?

When he checked into New York city's Columbia-Presbyterian Medical Centre last month, a subdued Ali did admit that he had been in the boxing ring for 30 years and that he has had to take a lot of punches

Some punches! For a typical blow from a heavy weight can land with a force exceeding 454 kg and it can snap the opponent's head, back or twist it violently causing the soft brain tissues to slam against the bony skull This can result in stretching, twisting or rupture of nerve cells and blood vessels. Moreover, like any other damaged tissue, the brain can literally swell to push itself against the inside of the skull, leading to further damage.

"Punch drunk" boxers have long been known to be men who took considerable punishment in the ring. And according to some neurologists, the boxer's chances of suffering brain damages rose in direct proportion to the number of bouts fought Autopsies have revealed that boxers are far more likely to have a condition called *cavum septi pellucidi* – a gap between the two membranes that divide the brain. Many boxers with this condition apear to suffer from Parkinsonian symptoms similar to Ali's

Indeed in 1983, the American Medical Association (AMA) carried an article in its journal stating that "the principal purpose of a boxing match is for one opponent to render the other injured, defenseless, incapacitated, unconscious. . Boxing, a throwback to uncivilised man, should not be sanctioned by any civilised society "

Ecocide, a crime

A RECENT report from the Stockholm International Peace Research Institute (SIPRI) warns that the threat of "environmental warfare" should be taken seriously by the world community. According to it, the dropping of nuclear bombs in Hiroshima and Nagasaki did **not** constitute the most devastating single act of war in history, it was the dynamiting of the Hyayuankow dyke of the Yellow River in China to stop the advancing Japanese troops in 1938, which drowned hundreds and thousands of Japanese and Chinese.

The Enmod Convention (short for Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques) banned environmental warfare. It was signed in 1977 after the world opinion was convinced about the US's role in causing environmental damage in Vietnam. US planes seeded clouds over IndoChina to "stimulate extra rainfall in local areas where the rainfall was already very heavy", says SIPR. The aim was to frustrate the movements of guerrillas by further waterlogging of their jungle footpaths. For seven years rain clouds were seeded. The US also sprayed lethal pesticides on crops and on acres of fertile rice fields, again to deteriorate the environment and reduce soil-fertility. Even now years after the war, one of the major problems faced by the hardy Vietnamese is to till their 'poisoned' land and somehow make it yield some agricultural product.

The SIPRI group wants a new convention to make all forms of "ecocide" an international crime. Some other acts of environmental damage which it has stressed are:

(1) Wafting of soot across polar ice sheets would alter the ratio between the amount of light reflected from the ice's surface and light directly received from the Sun. This would cause temperatures to rise, melt the ice and raise the sea levels considerably. This is already happening in a small way and it is predicted that the melting of the east Antarctic ice sheet would raise the seas throughout the world by 70 metres!

(2) Satellites could emit halogens into the lower stratosphere and hence 'puncture' the ozone layer. This would allow dangerous amounts of ultra-violet radiation to penetrate enemy territory with "serious biological consequences".

(3) Conventional and nuclear weapons could do irreparable damage to the environment. A nuclear device could trigger a landslide, earthquake or seismic sea wave, especially in known geologically unstable areas.

Models in zoos

A RUBBER snake in place of a real one in Houston zoo has caused a commotion in the zoo world. A regular zoo visitor noticed that a Texan coral snake had not moved in nine months!

John Mclain, the assistant curator of reptiles at the zoo explained that coral snakes are difficult to keep in capitivity, leave aside breed and zoo authorities were finding if difficult to maintain them. Several had died in the past few months. The zoo had no alternative but to use artificial models and hence the substituted model.

A herpetologist who is sympathetic towards the problem faced by the Texan zoo says "it is not such a bad idea."

However Bob Wagner, executive director of the American Association of Zoological Parks and Aquariums who does not approve of this practice intends taking the matter up with the Director of Houston zoo.

Particle accelerator

THE particle physics lobby in West Germany received a blow on a raw nerve when its latest particle accelerator, the DM 6,000 million (£ 1,600 million) HERA, was attacked by the press. In an article in *Der Spiegel*, West Germany's equivalent of *TIME* magazine, Richard Parlour, a British professor of atomic physics declared it to be "as useful as the Egyptian pyramids".

Though the physicists declared the article to be trash and apparently authored by an insider, the said article has been noted with glee by the Greens. The latter, who now occupy some parliamentary seats, represent the West German environmental and antinuclear lobby.

Not much harm has been done, though. To particle physicists, HERA will be a valuable complement to LEP, the electron-positron-collider under construction at the European centre for nuclear physics, CERN. Results from HERA and LEP are expected to complement each other. However, physicists say that if the article had been published during the decision-making period, which it just missed, the damage would have been greater. Now as it is, the matter will die with a few letters of protest to *Der Spiegel*.

Future computers

A SINGLE silicon chip will contain will contain more components than the number of cells in the human brain by 2000 AD. And slowly the chip-makers will do away with silicon and conventional materials for building computers as we are in for biological computers. The latter will be made partly or wholly of complex protein molecules as in living cells. These are the forecasts by one of Britain's top men in the computer industry.

Soon computers will be working ten times faster than the body and this trend will continue. Silicon chips will also double in complexity, getting smaller in size but not expensive. But caution is sounded by the experts. The present-day chips will need to pack so many components into a tiny space, that the components will be spaced at only a quarter of the wavelength light apart Light is now beginning to replace electrical signals as the computer's means of operation. But very small chips cannot use light. They will have to rely on X-rays with a much shorter wavelength. X-ray lasers will provide the necessary power.

Even typists will have to be done away with. Speech-recognition will transform the message dictation straight into the printed word. By 2000 AD, computers will make sense of a message, get the sense of rambling conversations and even recognise blurred or faulty pictures.

Don't underestimate babies

BABIES are born with the ability to differentiate between simple shapes, can recognise and remember objects in three dimensions and can distinguish colours without having to learn any of these processes Dr Alan Slater of the Dept of Psychology, Exter University, London, has shown these in his recent research. The aim of the research was to explore in detail the extent to which the newborn baby can make sense of what he sees.

Many babies were tested in the Exter area at an average age of two days Further tests were made between six weeks of age and one year Each test took about five to ten minutes and comparisons were made with test groups aged three and five months The baby was exposed to static or changing visual patterns until they no longer attracted his attention When the baby started losing interest in the visual patterns, the latter were replaced by new patterns, of which one is similar in some respects to the one replaced. If the baby looked more at the new pattern, then it indicated that he could discriminate between the two patterns and could also remember some aspects of the original pattern

It is widely known that babies look at a moving object But do they see the object or only detect the movement? The research carried out at Exter suggests that the baby can see the objects. It can also perceive an object in three dimensions when shown at the same time as a two dimensional picture of the object

Babies can also recognise squares and circles when presented at various angles And of course, they do not have to learn to coordinate their eye movements.

UN biotechnology

THE United Nations Industrial Development Organisations (UNIDO) decision to establish a biotechnology centre in a Third World country is making a steady but slow progress. Prolonged negotiations in previous meetings had agreed upon two centres--one in Trieste, Italy and the other in New Delhi, India

At the recent preparatory committee of the International Centre for Genetic Engineering and Biotechnology discussions centred around the funds the two host countries India and Italy, are willing to commit. The next meeting will be held in December 1984 in which a project leader and a scientific committee will be identified for each centre.

Regarding the financial commitments, the Government of India has offered $ 5 million towards the cost of first five year's work at the Delhi site, supplemented by an offer of $ 8 2 million from the Italian Government which has also promised $ 4 million and 13,000 million lire towards five year work at Trieste Even though the amount allocated is substantial, many experts feel that it is not sufficient to keep the project going Further, the two countries have also offered the cost of equipment. Rs 15 million (India) and 58 million lire (Italy) Italy will provide a building at Trieste at a token rental whereas India has agreed to spend Rs 72 million on land and buildings near Delhi.

These voluntary bids are expected to encourage others to contribute during the meeting to be held soon again in Vienna. But, whether the contributors will bring along promissory notes is uncertain This is because some would like to know which people are chosen in the next three months to manage the biotechnology centres, others the colour of their fellow-member's money. Doubts still persist regarding the decision to split the centre into two components Another danger which lurks is that the member governments may prefer to commit the funds to developments at home

Decisions are yet to be finalised about the division of work between Delhi and Trieste In all probability while the Delhi centre will be dealing with developments in agriculture and human health, the Trieste centre will deal with the application of biotechnology in the chemical industries and energy

Can simple thoughts heal the body?

THE question whether the mind can influence the immune system of the body has been bugging researchers for a long time and a definite answer has not yet been found. However, certain hints are emerging that the two are indeed related.

To study this relationship, a new discipline psychoneuroimmunology has been created and endorsed along with its parent field, neuroimmunomodulation, by the National Health Institutes (NIH) in the US. Also, the Institute for the Advancement of Health, New York, has been established to do research on the mind-body interactions in health and disease.

Writing in a recent issue of *Science Digest*, Signe Hammer says that a team of researchers studied bereavement, a stressful state combining depression and anxiety. This was to find answers to questions like whether there are specific psychological states that influence the immune system and whether this influence can be documented. They found that the response of the widowers' T and B cells (white blood cells) to a mitogen, a chemical that triggers lymphocyte activity, was "significantly suppressed". This finding was consistent with the hypothesis that changes in the immune system following bereavement are related to the increased mortality of bereaved widowers.

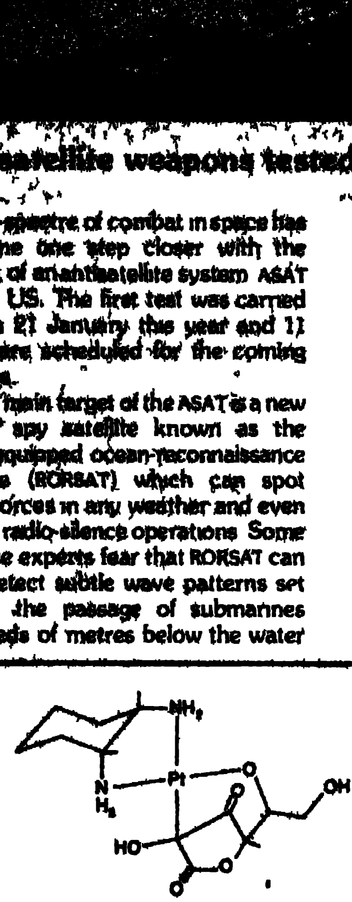
Neuroscientists and immunologists have also discovered that brain and immune systems are in continuous communication. Hence it is possible that the mind may enhance the immune system's work, just as it can, apparently, supress it. This is supported by a preliminary study on half a dozen cancer patients. The study indicated an improved state of immunity during periods when they imagined tumours (visualised as a dragon) attacked by white blood cells as knights with swords), was done by cancer patients, and a deficient state of immunity when it wasn't.

Antisatellite weapons tested

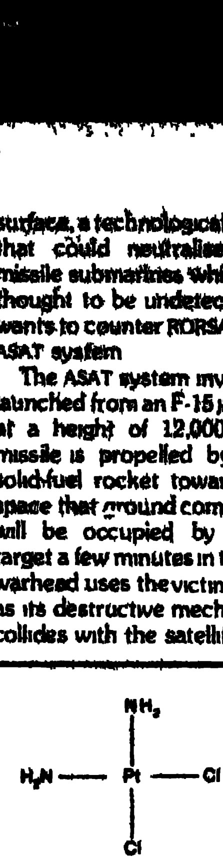
THE spectre of combat in space has come one step closer with the testing of an antisatellite system ASAT by the US. The first test was carried out on 21 January this year and 11 more are scheduled for the coming months.

The main target of the ASAT is a new Soviet spy satellite known as the radar-equipped ocean-reconnaissance satellite (RORSAT) which can spot naval forces in any weather and even during radio-silence operations. Some defence experts fear that RORSAT can also detect subtle wave patterns set up by the passage of submarines hundreds of metres below the water surface, a technological breakthrough that could neutralise US Trident missile submarines which were so far thought to be undetectable. The US wants to counter RORSAT by using the ASAT system.

The ASAT system involves a missile launched from an F-15 jet fighter flying at a height of 12,000 metres. The missile is propelled by a two-stage solid-fuel rocket towards a point in space that ground computers predict will be occupied by the intended target a few minutes in the future. The warhead uses the victim's momentum as its destructive mechanism when it collides with the satellite.



New platinum complex



Cisplatin

An anticancer avatar of ascorbic acid

STRUCTURALLY different from the widely used anticancer drug cisplatin, new compounds—Platinum complexes of vitamin C—show anticancer activity in both cis and trans forms. These compounds developed in the UK represent the first complexes of ascorbate and a transition metal that have been completely characterised.

Ascorbate has long been known [illegible] interact with metals in the body, particularly copper, but the complex has proved difficult to isolate and characterise. Because the compounds are structurally so different from cisplatin, it seems likely that they either represent a genuinely new class of antitumour agents with a different mode of action, or that the current knowledge of the mechanism of the [illegible] activity needs to be revised. [illegible]

Quick multiplication of large numbers

MULTIPLICATION of a large number by any other number is a laborious task However, if the following technique is made use of the result can be obtained within seconds. Consider an 18 digit number, 526315789473684210 Let us say we want to multiply this number with 6349. To get the answer observe the rules below:

1 Divide 6349 by 19 mentally to get the answer 334 (quotient) with 3 as remainder
2 Use only the remainder 3, by keeping this at the units place (extreme right), then multiply by 2 and place the value 6 in the tenth's place Again multiply by 2, the last value obtained (6) to get 12 Place 2 in hundredth's place and neglect 1

**3. . . *63. . 263 (neglect 1)

3 Find where exactly 263 fits in the 18 digit number Here 5**263**15789473684210
4 Subtract the quotient 334, obtained in the first step from the above number In case subtraction is not possible, take one more digit from the 18 digit number In this case it is 5, that is, 5263 − 334 = 4929
5 All what you need is now write the quotient first, then write all the digits starting from where the earlier number fitted in 15789 in a cyclic manner and substitute the value obtained in step 4, in place of 5263 (4929 in stead of 5263)
6 End with

so we get the answer as
334157894736821049290
Quotient Substitution

There may be cases which may look somewhat deviated from the above procedure, as for instance the remainder 8 In such cases when on multiplication by 2, a two digit number is obtained, take only the unit value, but on the next multiplication add 1 to the answer

**8 . ___ *68 . _ . __ 368 (1 added to 12)

Where the remainder is 0, the answer will be a series of 9's followed by 0

Where the remainder is a 2 digit number say 13, use only 3, but on subsequent multiplication by 2, add 1 to the answer

**3 . ___ 73* . . . . 473 (1 added to 6)

M.C.V. Subramaniam

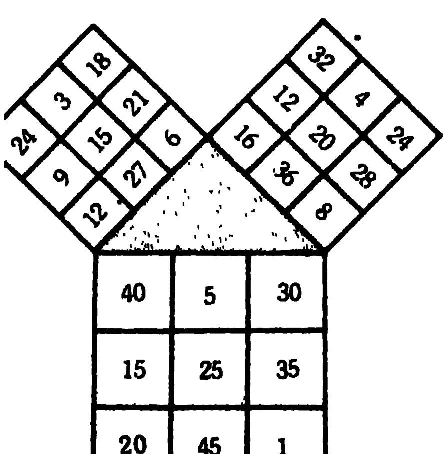
Mr Subramaniam is a final year student of Computer Science at Indian Institute of Technology, Kharagpur

---

Tri-tetra and penta magic squares

MAGIC squares of order-3 can be constructed on the sides of an equilateral triangle using the integers from 1 to 27 with no integer appearing twice The tri-magic squares thus formed have each a magic constant of 42 However, one is faced with the limitation that two out of the three squares are irregular or semi magic, that is, their diagonal elements do not add up to 42

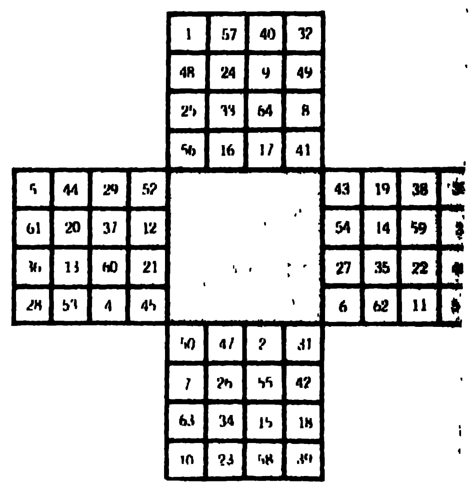
An interesting example of tri magic squares is the order-3 square formed on the sides of a right-angled triangle If c is the magic constant of the square formed on the hypotenuse and a and b the corresponding magic constants of the squares formed on the sides of the right angled triangle, them the relation satisfied between a, b and c is $a^2 + b^2 = c^2$ which is the analogue of the Pythagorean theorem This can be easily verified for the tri magic squares in Fig 1 Here a = 45, b = 60 and c = 75 so that $75^2 = 45^2 + 60^2$ or 5625 = 2025 + 3600 or 5625 = 5625



Interesting relations exist among the elements of the tri magic squares in Fig 1 Square of any element of the square z formed on the hypotenuse is the sum of the squares of the corresponding elements appearing on the squares x and y formed on the sides of the right angled triangle Thus, $15^2 = 9^2 + 12^2$, $40^2 = 24^2 + 32^2$, $25^2 = 15^2 + 20^2$ and so on

Tri-magic squares of the above example can be easily constructed starting from the relation $5^2 = 3^2 + 4^2$ They the elements of the square z on the hypotenuse are formed by using 5 and its multiples while those on the sides x and y are formed respectively using the digits 3 and 4 and their multiples

Tetra magic squares can also be formed by constructing order 4 magic squares on the sides of a square These magic squares utilize the integers from 1 to 64, both inclusive, with no integer appearing twice All the four magic squares produce the same magic constant of 130 (Fig 2) It is interesting to note that the numbers in all the four horizontal as well as the four



vertical rows each comprising eight cells add up to 260

Penta magic squares are magic squares of order 5 and are formed by using the integers 1 to 125 with no repetition of any integer on the sides of a pentagon All the five magic squares produce the same magic constant of 315

P.K Mukherjee

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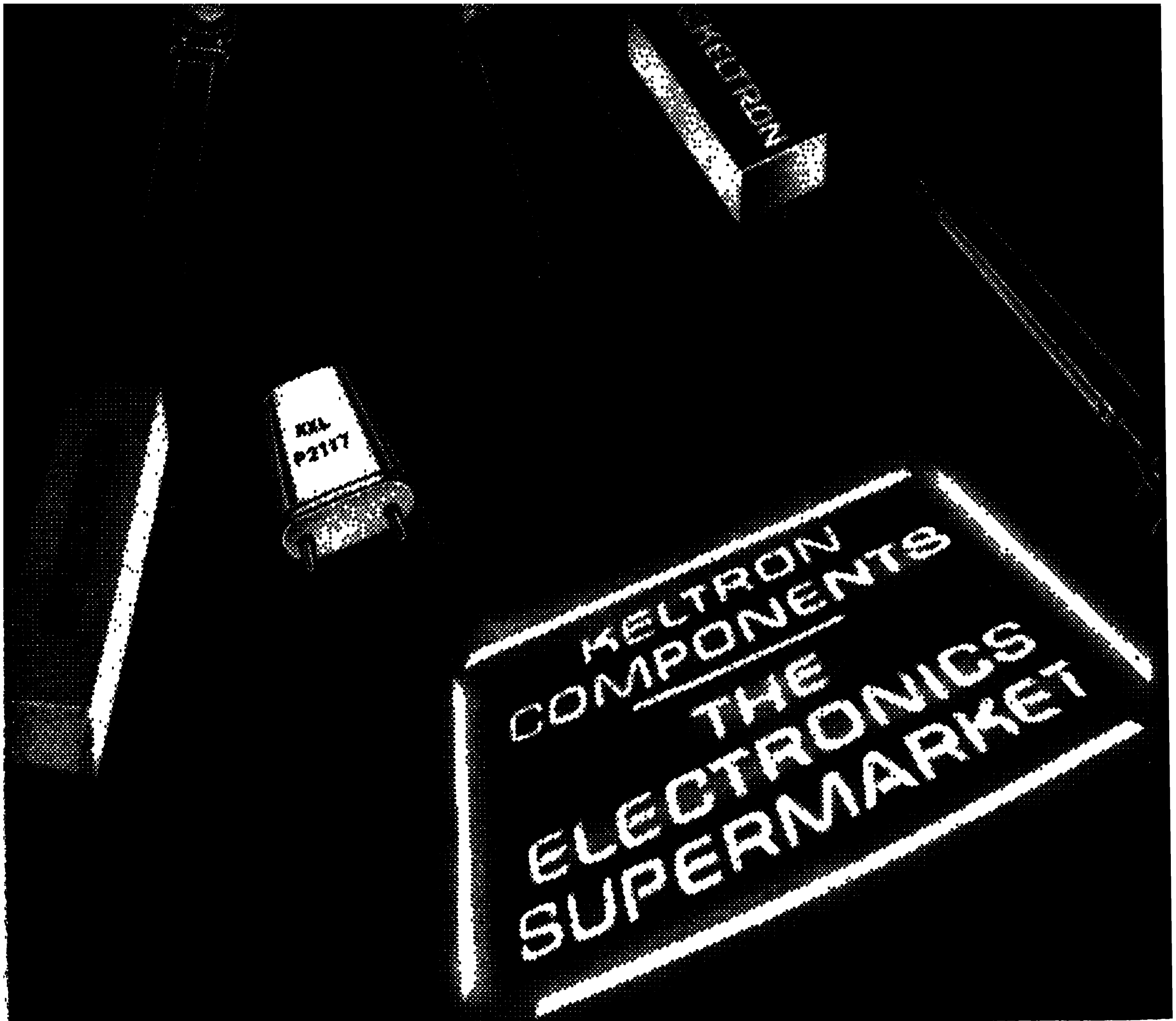

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BUILDING OF DAKSHIN GANGOTRI

Harsh K. Gupta

ANTARCTICA, with an area of about 14 million square kilometres, is the fifth largest continent in the world It has superlative physical characteristics Ninety-eight per cent of the continent is covered with a thick ice sheet, with an average thickness of 1,800 metres At places, drilling has revealed the thickness of the ice sheet to be in excess of 4 5 kilometres With an average elevation of 2500 metres, it is the highest continent The world's record of the lowest temperature of minus 88°C was made on 24 August, 1960 at Vostok, a Soviet Station at Antarctica With an annual rainfall of only 10 centimetres, it is also the driest continent.

Antarctic research comes of age

The immense riches and boundless extremes of the Antarctic Continent and the surrounding seas attracted voyagers from very early times During 1772-75, British explorer James Cook's vessel '*Resolution*' crossed the Antarctic circle and circumnavigated the Antarctic Continent The Antarctic Peninsula was discovered in 1820 by Nathaniel Palmer of the U S A James Weddell, a British explorer, discovered the Weddell Sea in 1823 During the first two decades of the 1900s, commonly known as the 'heroic era' of Antarctic exploration great inroads were made into the geographic and other scientific knowledge of the continent National prestige in territorial acquisition and scientific enquiry provided strong motivation for governments and private organizations to support these expeditions

A considerable amount of attention was paid to Antarctica during the International Geophysical Year (1957-58) Twelve nations involved in Antarctica (Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, South Africa, United Kingdom, the United States and the USSR), seven of which had made

The MI-8 helicopter being taken out from the ship (right) and with underlung (top)

territorial claims, realized the importance of international co-operation in scientific research in Antarctica, keeping aside the political and legal differences. The results were very encouraging and this made the involved nations realize the need of some stable special regime. The negotiations started leading to the formulation of the Antarctic Treaty (See Box).

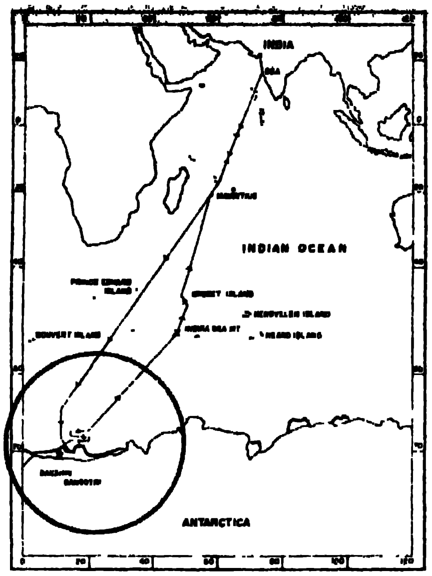
The third Indian expedition

The 81 members of the Third Expedition team consisted of civilians (sixteen including two lady scientists), personnel from the Indian Army (thirty-eight), Navy (twelve), Air Force (twelve) and the Armed Forces Medical Service (three). The team members were chosen from among the volunteers who had offered their services for the expedition. This young team (average age 32 years) had to undergo a medical examination, and high altitude training and acclimatisation to cold weather at the Machoi Glacier. This was the first time two lady members were included in an Indian team to carry out scientific work in the Antarctica.

The Expedition sailed off from Goa on 3 December, 1983 on board *M.S Finn Polaris*. This chartered vessel from Finland is capable of cutting 'fast ice' of up to 70 cm thickness, and had been suitably modified to store four helicopters in her holds, in addition to carrying some 900 tonnes of cargo. After a brief stop at Port Louis, Mauritius, the ship continued its southward journey. The first iceberg was sighted on 18 December, 1983 and this created a lot of excitement among the expedition members. The *fast ice* had started breaking up but the *shelf ice* was still not approachable. On 27 December, the ship was moored on fast ice where the friendly penguins flocked around to welcome the visitors.

The permanent station

One of the principal aims of the expedition was to construct a permanent station at Antarctica. On



The route to Dakshin Gangotri

reaching Antarctica on 27 December, 1983 work on this task commenced immediately. A camp was established at the site selected after careful studies of the aerial photographs, regional maps and other available material and reconnaissance of the region. The construction party (the Army Corps of Engineers) moved into this camp on 28 December, 1983. It was crucial to keep the construction party well supplied with their requirements of construction material to enable them to complete the task in the very limited available time. Initially, when the ship was moored to fast ice, construction material loads were carried by the helicopters. Two unloading parties of ten members each were organised. Work commenced at 8 am and often continued till midnight. The unfortunate MI-8 helicopter crash in the afternoon of 28 December, 1983, while carrying an underslung load, considerably upset the unloading schedule. Due to the timely rescue and brave, untiring efforts of the medical officers all the five members of the ill-fated flight were saved. This unfortunate event did not deter the team and the members worked with enhanced dedication to meet the challenges and accomplish the job.

The resources of Antarctica

The scientific expeditions carried out so far have revealed immense economic potential in the form of mineral and living resources. Large reserves of gold, platinum, silver, zinc, cobalt, lead, copper, iron, etc. have been reported to occur in Antarctica. The Transantarctic mountains, running some 2500 km in length, are believed to have the world's largest coal deposits. Without doubt, the main attraction in the Antarctic is likely to be oil and gas. By comparison with the sedimentary basins on continental shelves in other regions of the world, the oil potential of the Antarctic continental shelves is considerable. Various, rather speculative, estimates have been made of these reserves. According to an estimate, based on U.S. surveys, as much as 45 billion barrels of oil and 115 trillion cubic feet of natural gas lie off the Antarctic coast. But any attempt to exploit Antarctic oil could be prohibitively expensive: the remote location and severe climatic conditions add to the increased cost of production. Nevertheless, interest in Antarctic oil and gas is growing and it is likely that with the technological development, exploitation of these resources would become economically viable in the foreseeable future.

In addition to the mineral and oil reserves, Antarctic seas are very rich in a wide variety of marine life, particularly krill, a very rich source of protein. Krill is the most easily exploitable of the Antarctic resources

India joins Antarctic research

India is drawn to Antarctica, not only due to its mineral, oil and living resource wealth, but also due to Antarctica's geographic location which considerably influences the climate of the Indian sub continent. In the geological past, India, Antarctica, Australia, Africa and South America were all together forming the supercontinent known as 'Gondwanaland'. Some 160 million years ago, this supercontinent split up and different portions moved to their present day positions. A comparative study of rocks from these continents is extremely important for understanding various geological processes and phenomena. From the oceanographic point of view also, observations in high southern latitudes are extremely important.

India's dream to explore Antarctica became a reality when the maiden Indian scientific expedition to Anarctica, under the leadership of Dr. S.Z. Qasim, landed on the frozen continent on 9 January, 1982. The Department of Ocean Development, Government of India organised the second expedition during 1982-83, lead by Mr. V.K. Raina. Encouraged by the success of these two expeditions, the DOD planned the third expedition during 1983-84. In addition to carrying out multi-disciplinary scientific observations and experiments, it was decided to set up a permanent station at Antarctica to sustain continued scientific work during the winter months

The second MI-8 helicopter was brought out and put into operation on 2 January, 1984. Unless absolutely essential, the underslung operations by MI-8 were avoided This necessitated opening up of the preslung loads, loading them piece-wise in the fuselage of the helicopter at the deck of the ship and similarly unloading them at the camp site, a very time-consuming and laborious process However, all concerned did an excellent job. In the meantime, constant efforts were being made by the ship to reach the ice shelf so that unloading could be carried out on the sledges to be pulled by piston bullys The ship finally reached the shelf on 21 January, 84 and was completely unloaded by 30 January, 1984.

Right from the beginning, the construction team worked hard, not bothering about the adverse working conditions. Towards the end of January 84, the double storeyed super-structure of the permanent station was more or less ready. During February, the weather deteriorated considerably, and working outside became increasingly difficult. A number of problems were encountered in commissioning various internal plants and services. However, the army engineers were able to cope with these difficulties. A certain amount of fabrication was carried out at the ship's workshop. Various systems, such as heating, electrification etc and plants such as the generators, snow melting plant etc were tested as and when installed. The scientific laboratories were totally functional on 23 February On 24 February, the 'winter party'* moved in The permanent station, named *Dakshin Gangotri*, was hit by a blizzard which lasted for four days, on 25 February Wind speeds of upto 80 knots (about 145 km/hour) were experienced During the blizzard, in addition to the 'winter party' there were 28 other members of the team at the station The blizzard proved to be the acid test for durability and functioning of the various facilities of the station Barring a few minor problems, every thing worked well.

The permanent station consists of two double storeyed prefabricated timber structure blocks specially designed for Antarctic conditions. The two blocks have sloping roofs forming lofts created for storing The blocks are linked by a single storey corridor The building complex is designed to withstand winds of upto 100 knots (about 180 km/hour) The building rests on a 620-square-metre raft foundation, excavated to one metre depth, extending some two metres beyond the perimeter of the super-construction to ensure uniform distribution of load on ice. Styrofoam has been used in all the panels to restrict heat loss. On the outside, thermal insulation is provided by placing a 2.5 cm thick layer of foil below the cladding. The station is totally self

The Antarctic treaty

THE Treaty was signed in 1959 by the 12 nations which had maintained stations there during the International Geophysical Year (1957-58): Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, South Africa, the United Kingdom, the United States and the USSR.

The Treaty is open to any member of the United Nations. Sixteen nations have joined since it came into force in 1961: Bulgaria, Brazil, China, Czechoslovakia, Denmark, the Federal Republic of Germany, German Democratic Republic, India, Italy, the Netherlands, Papua New Guinea, Peru, Poland, Romania, Spain, and Uruguay.

The Treaty explicitly aims to further the purposes and principles of the United Nations Charter. Among its more important features are:

* Stipulates that Antarctica should forever be used exclusively for peaceful purposes and not become the scene or object of international discord;
* Prohibits nuclear explosions and the disposal of nuclear waste, and measures 'of a military nature';
* Guarantees freedom of scientific research throughout Antarctica, and promotes the exchange of information on scientific programmes, of scientific observation and results, and of scientific personnel;
* Establishes a comprehensive system of on-site inspection by observers to promote the objectives and ensure the observance of the Treaty; and
* Removes the potential for soveriegnty disputes between Treaty parties This safeguard is contained in Article IV, which ensures that the legal position with respect to sovereignty of Treaty parties is not prejudiced by any acts or activities taking place during the period of the Treaty. No new claim, or enlargement of an existing claim, may be asserted while the Treaty is in force.

The Treaty applies to the area south of 60° south latitude, but without prejudice to the high sea rights of any state under international law.

The Treaty is designed to provide a framework for activity in Antarctica indefinitely, and has no set period of operation. There is provision for a conference of all the contracting parties to be convened to review its operation if a request is made by one of the consultative parties Such a request can be made after the expiration of 30 years from the date of entry into force of the Treaty, i.e. after 1991

The 12 original signatories are known as consultative parties and are entitled to participate in Antarctic Treaty Consultative Meetings. Further, any party to the Treaty which demonstrates its interest in Antarctica by conducting substantial scientific research activities there is entitled to be a consultative party. Thus Poland in 1977 and the Federal Republic of Germany in 1981 became consultative parties Recently (1983) India became a consultative party.

H.K.G.

contained for the winter party of 12 personnel and is equipped with garage, workshops, laboratories, living accommodation, surgery, toilets, kitchen, stores etc. The station is powered by three 62.5 KVA diesel generators, being duty, maintenance and stand-by generators, synchronised with a manual change-over system. The peak load of the station is 40 KVA. As a safety measure, the bulk of the fuel is stored at a distance from the station. There is a 5000-litre tank in the building which needs replenishment once every eight to ten days. The living area is heated by low pressure hot water radiators Two oil-fired boilers have been provided for heating and snow melt plant usage. Hot and cold water is available at all supply

continued on page 63

***Foundation of the permanent station* (top)**

***Interior lab view at Gangotri* (right)**

***A few of the laboratories at Dakshin Gangotri. Dr. Hanjura with micro-biograph recorder* (below left)**

Prabhu Matondkar, veteran of all the three Indian expeditions and the microbiologist-shows agar plates with microbial growth to Dr. Gupta. Also seen are Dr. Hanjura and Dr. Sudipta Sengupta

A Lifetime Experience

ANTARCTICA with its 14 million sq. km area is still the least known and most inaccessible continent on the face of the Earth. Here are the world's strongest wind, lowest temperature, highest land and icemasses, hardiest animals and seas richest in life. The Greeks called this unknown continent in the extreme south the *antartikos*, meaning opposite the Bear, the Bear being the northern constellation. Though there were several attempts to explore this last *terra incognita* on this planet, it took men several centuries to set foot on the real continent

In 1983-1984, the third Indian research expedition was launched not only to carry out further research but also to build a permanent research station on this remote continent so that Indian scientists can work there round the year. I joined the last expedition as a geologist and was fortunate enough to work in this great natural laboratory where the tremendous force of nature is felt under the apparent calm of the changeless icescape

The Journey to the South

The journey from Goa to Antarc-

***Wandering albatross* (top)**
***The crab-eater seal who paid a visit* (above)**
***Skua—the Antarctic hawk* (left)**

tica showed a variety of sea-scapes and life forms which made the voyage interesting and lively. The equatorial waters do not contain many life forms but after we crossed the thirties (30°S latitude) the monotony of sea-life was broken by flocks of birds -- different varieties of prions, petrels, albatrosses and cape pigeons

Glacial tongue in the Schirmacher range

The albatrosses, with their elegant, effortless gliding through the vast expanse of blue were indeed a treat to the eye. Linnaeus, the famous Swedish biologist, named this genus as *Diomedea*, possibly after the Greek mythological hero whose companions were transformed to birds at his death. Masters of gliding flight, they can remain airborne for a good length of time without flapping their wings even once. They have stout bodies and extremely long and narrow wings. Among the wandering albatrosses, the largest species may have a wingspan of nearly four metres. The plumage may be brown, black and white. Of the eleven species of albatrosses, nine are truly southern in the sense that they inhabit the southern ocean from latitude 30°S When not breeding, they roam the high seas for months and circum-navigate the world They return to nearby islands to breed and one chick in two years is enough to maintain the population balance Seamen consider killing these birds a bad omen.

With the albatrosses stealing the main show, petrels and prions were relegated to side roles. Prions (genus: *Pachyptila*) are small birds, always in flock. They danced on the waves with gay abandon when they gathered food from the water surface The petrels are bigger, have hooked beaks and black plumage They come in different sizes, ranging from that of swallow size storm petrel(family: *Hydrobatidae*) to the one-metre long giant petrel(*Macronectes giganteus*). They are named after St Peter, probably because of his legendary walk on the lake of Gennesareth. Several varieties of petrels were seen in this voyage. Dr K. J. Mathews, our biologist and the Finnish crew member Nako were ready to help us identify them.

Free to move without any hindrance of landmass, the water around Antarctica along the forties and fifties remains perpetually turbulent. We were fortunate that the roaring forties did not give us any trouble but the seascape suddenly changed when we entered the screaming fifties. For five days we had stormy sea around us. Even in a large ship with modern facilities we felt uncomfortable, and could appreciate the courage of those pioneers who first dared to cross these rough seas in small sailing ships.

After we crossed the Antarctic Convergence, where the Antarctica cold water meets the warmer water of the Southern hemisphere, Cape pigeons (*Daption capensis*), beautiful birds with black and white designed plumage, were often seen. Further south, once we crossed the Antarctic circle(66° 30'S latitude) the milk-white snow petrels(*Pagodroma nivea*) and almost black Wilson's petrel(*Oceanites oceanicus*) became more common

Nearing the continent

The sea surrounding Antarctica remains frozen almost round the year A part of the frozen fast ice breaks up in austral summer and is carried away northward by oceanic currents. These broken pieces or floe ice may have a thickness of upto four metres and are five to 100 metres or more in length The pack of floe ice forms an annular ring around the Antarctic continent and is referred to as pack ice The fast ice and floe ice of frozen saline sea are quite different from icebergs which are derived from the continental ice sheet.

The Antarctic ice sheet with its 29 million cubic km of ice is the largest transient load on the Earth's crust Under the effect of gravity, the ice sheet flows from the interior towards the ocean with an average speed of a few metres to tens of metres per year, where the coastal relief is gentle. This situation is typical of more than one third of the continent. In areas of irregular sub-glacial terrains and mountains, the ice sheet flows outward as mountain-valley-glaciers with an average rate of 100 metres to 1000 metres per year. The ice sheet flows out beyond the limit of the underlying rocky coast and forms the coastal ice shelf—a 200-metre to 1500-metre thick floating apron that comprises more than 10 per cent of the continental area. The ice shelf gradually breaks apart from the mother ice sheet and floats away as icebergs. The newly formed icebergs are flat-topped but as they erode they become conical or irregular in shape. With progressive northward movement, the icebergs gradually decrease in size and form growlers. These growlers are navigator's nightmares as they are too small to detect by radar but big enough to cause damage to the ship

Antarctic panorama

As we crossed the belt of pack ice between 65°S and 69°S latitude the real Antarctica panorama was revealed. Vast expanses of white and blue gave the scenery an out of the world look. The deep blue ocean, the milky white ice chunks with sea green edges, massive, sombre icebergs at the distant horizon against a backdrop of azure blue sky and an over-bearing silence all over transpired an unreal situation Here and there on the pack ice one or two seals or a flock of curious penguins would complete the Antarctic touch.

Pack ice is the favourite place of Antarctica seals to bask in the sun in austral summer. Very often we would see one quite unperturbed by the presence of the ship, lying still on a floe or lethargically lifting its head. Antarctica has four species of seals endemic to this continent which suggests isolation of the continent through a

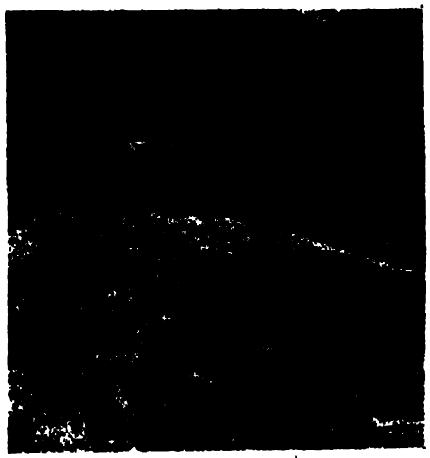
"Antarctica is one large laboratory in which any type of scientist can find not only significant problems in his field but also a sense of personal satisfaction and achievement in tackling those problems in an arduous but fascinating environment" —T. Hatherton

prolonged period of evolutionary history. All the four species belong to the family *Phocidae* and are genetically remote from their northern counterparts. They are more marine and spend most of their life in water. While swimming in the sea, they use their limbs as their principal means of propulsion. Consequently they use only their forelimbs to carry themselves on land or ice, almost like eels. The same seal that looks cumbersome and gawky on ice, turns into a lithe, agile swimmer the moment it plunges into water.

Amongst the four species the Ross seal is the rarest. The Leopard seal, named for its ferocity and colour, is carnivorous and lives on penguins and young of other seals. The crab-eater seal, the most common variety, lives mainly on krills—a shrimp-like crustacean, *Euphausia superba* The most polar seal of all is the Wedell seal which is non-migratory and spends most of its life on the fast ice found all around the continent. It lives on fish, squid and bottom invertebrates of the southern seas A fact that still bewilders scientists is that a large number of mummified seals are found deep inside the continent where they possibly died of starvation. Carbon-14 dating showed that some of the carcasses are several thousand years old. One group believes that these seals must have lost their way and wandered inland until death ended the journey. Whereas another group believes that they lived there when the climate was warmer and when the sea extended far inside.

In contrast to the indifferent seal, the penguins are inquisitive and friendly. The large emperor penguin *(Aptenodytes forsteri)* is definitely more royal in its bearing, but we usually encountered the smaller adelie penguins *(Pygoscelis adelie)*. At sea the penguins move in flocks, diving and surfacing like porpoises with wings used for propulsion and feet serving only for steering. When they come out of water, these birds can leap upto three metres vertically to land on ice just like jacks-in-the-box. They live mainly on krills and hence are limited to the coastal area.

The emperor penguin begins nesting in autumn and lays a single egg in the dark of winter. They do not have any fixed nest-site like the adelies but merely carry their eggs on the top of their feet and against a patch of abdominal skin. Strangely it is only the male which incubates without any food for the whole period of two months. In spring the adelie penguin nests on stones or bare patches of rock to lay one or two eggs. It incubates them in normal fashion Both the parents share the thirty-five days of incubation period.



'Honey comb' weathering of gnessic rocks of Schirmacher range

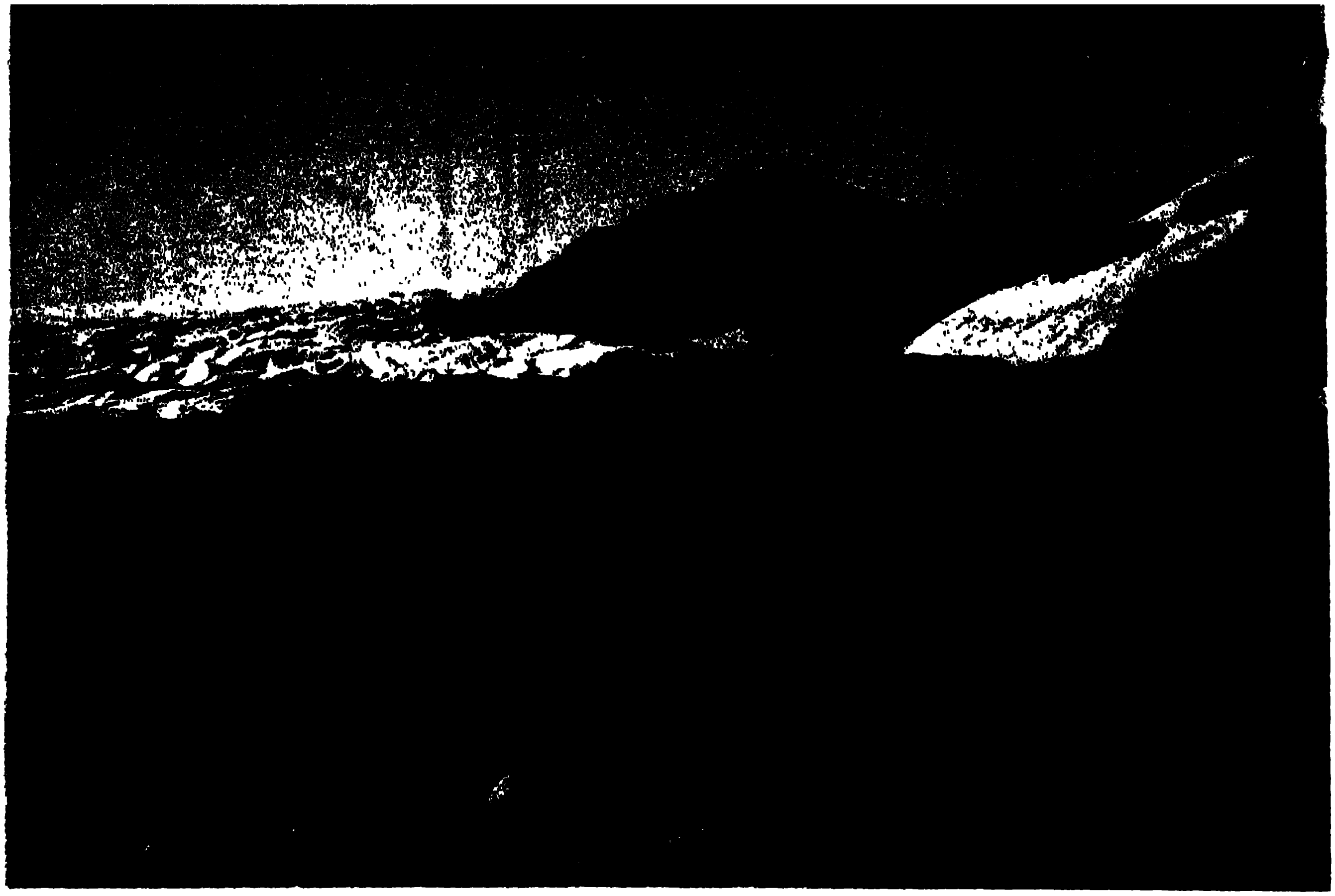
The most southern of all Antarctic birds is skua *(Catharcta mackormicki)*. It is seen within 100 km of the geographic pole The skua is predatory and extremely aggressive in nature. It lives on other small birds or on the eggs of penguins Now they often fly around manned stations or ships in the hope of food. When we were doing our fieldwork in the hill range, a skua used to follow us all day to get the leftovers Once, I found a chick and managed to take a photograph while the parents hovered angrily over my head.

The arrival

After making our way through the pack ice we passed through a narrow zone of clear water for some distance. However, at position 69° 57' 7", 12°48' 9" E the ship could not proceed any further and she had to moor on the fast ice itself. It was during the early hours of 27 December. The day was bright, sunny and without a hint of the fierce Antarctic wind. A group of adelie penguins came to greet us. Curious and human-like they would come very close to us but would glide away on their bellies like a toboggan the moment anyone tried to catch them. We also had a visit from a crab-eater seal who dragged its body over the ice across a long distance. It got nervous when surrounded by a group of photographers and quickly slided into the sea.

In Antarctica one always underestimates distances because of the unusual clarity of the air. The ice shelf which was three km away, appeared much nearer. On the same day the activities started. The heavy snow vehicles disembarked on the fast ice itself and were quickly driven away to the safety of the ice shelf through a convenient ice ramp since the ice shelf was about three metres higher than the level of the fast ice. The site of the permanent research station was selected and on 28 December, a group of army engineers and their men left to set up the base camp and to start the construction of the station.

The everpresent danger of an Antarctic expedition suddenly became apparent when on 29 December, a Pratap (MI-8) helicopter crashed into the icy water. Though we were relieved to see the five occupants breaking out through a window, we knew that they were still at considerable danger. One cannot survive for long in water at minus 1.8°C. Standing on deck we fervently hoped that there were no killer whales around. A Chetak helicopter was ready, available for rescue and a boat was lowered immediately. Fortunately all five were saved without any serious injury.



On 12 January, a group of scientists moved to set up a camp on the Schirmacher range - an oasis hill range approximately 70 km from the coast. Three geologists (Dr Madanlal, Mr. R K Singh and myself), one biologist (Mr. Prabhu Matondkar) and a doctor (Lt Cdr. A Banerjee) stayed there for 25 days while other scientists took turns in visiting the camp for few days

Geology

The continental ice sheet, ranging in thickness from 2 Km to 4 5 Km, covers 98 per cent of the Antarctic land mass and only 2 percent of the continent is exposed in the form of mountains rising above the ice sheet along the coastal regions and along Transantarctic mountain range This huge mass of ice with a volume of 29 million cubic Km has depressed the rocky surface of the continent by 600 m

The Antarctic continent forms a key block in the jig saw puzzle of the continental drift theory This theory, first proposed by Alfred Wegner, postulated that the continents of South America, Africa, India, Australia and Antarctica were all joined together and formed the super continent of Gondwanaland About 200 million

***Schirmacher range with glacial lake** (top)*

***Adelie penguins** (below)*

years ago these continents broke apart and gradually moved to their present positions. Although Wegner's theory has been considerably modified and is replaced by the modern theory of plate tectonics, his basic tenet of continental dispersal is still valid and there is evidence to prove that the continents were once joined together

Geologically, the continent of Antarctica can be divided into East and West Antarctica with the Transantar

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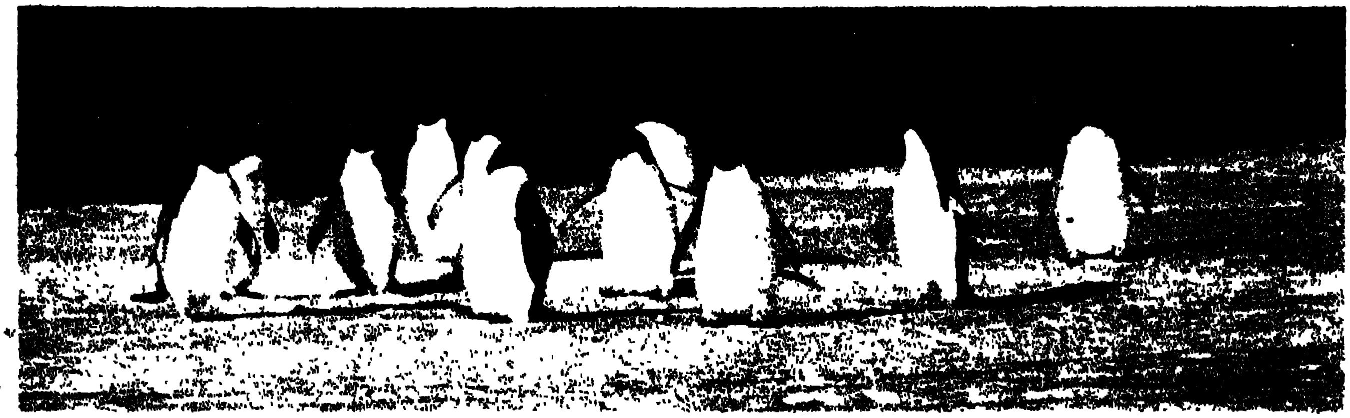


HEADACHES

DOCTOR, I am about 55 years old and have high blood pressure for the last five years. I am taking medicines regularly Now, for the last one month I have been getting dull, boring headaches mainly at the forehead. I hope there is nothing seriously wrong.

First, let me explain to you something about headaches The term headache encompasses all aches and pains located in the head Medically speaking, its significance is often abstruse, for the headache may stand as a symptomatic expression of an underlying disease or, on the other hand, it may be due to some minor tension or fatigue, incident to the affairs of the day. It is this dual significance, benign and potentially malignant, that keeps the physician on the alert

But how do we differentiate various types of headaches? When should one consult a specialist?

Simple things like lesions of sinuses, teeth, a refractive error in the eye or glaucoma or an infection in the ear, each of these can cause a headache which is not sharply localised Headache from sinusitis may appear on awakening and in mid-mornings and is characteristically worsened by stooping. Eye strain-headaches follow prolonged use of eyes as in reading, watching cinema, etc Hypertensive headaches tend to occur on walking in the morning and excitement, anger and tension may provoke them further

The duration of a headache is equally important When it is chronic, recurrent and associated with or without other symptoms, care should be taken and then one should consult a specialist

Doctor, I am suffering from this headache for the last one month, whereas my elder brother for the last three years Does this have any significance?

When a headache becomes chronic, various factors are considered For example, in migraine there is family history in 80 per cent of cases, with onset in childhood or adolescence There is a unilateral throbbing pain, sensitivity to light and sound, nausea and sometimes even vomiting When all these symptoms are present, diagnosis is easy

On the other hand, "cluster headache" is more common in males It is constant, intense, has unilateral orbital localisation, tends to recur nightly for several weeks or even for months and the pain of a given attack may leave as rapidly as it began Clusters may recur over the years, more

likely in times of stress and strain, overwork and upsetting emotional experiences

Similarly headaches caused by tension are usually bilateral, diffused, and are described as "fullness", "tightness" or "pressure" This is the only headache, which persists for a long period of time

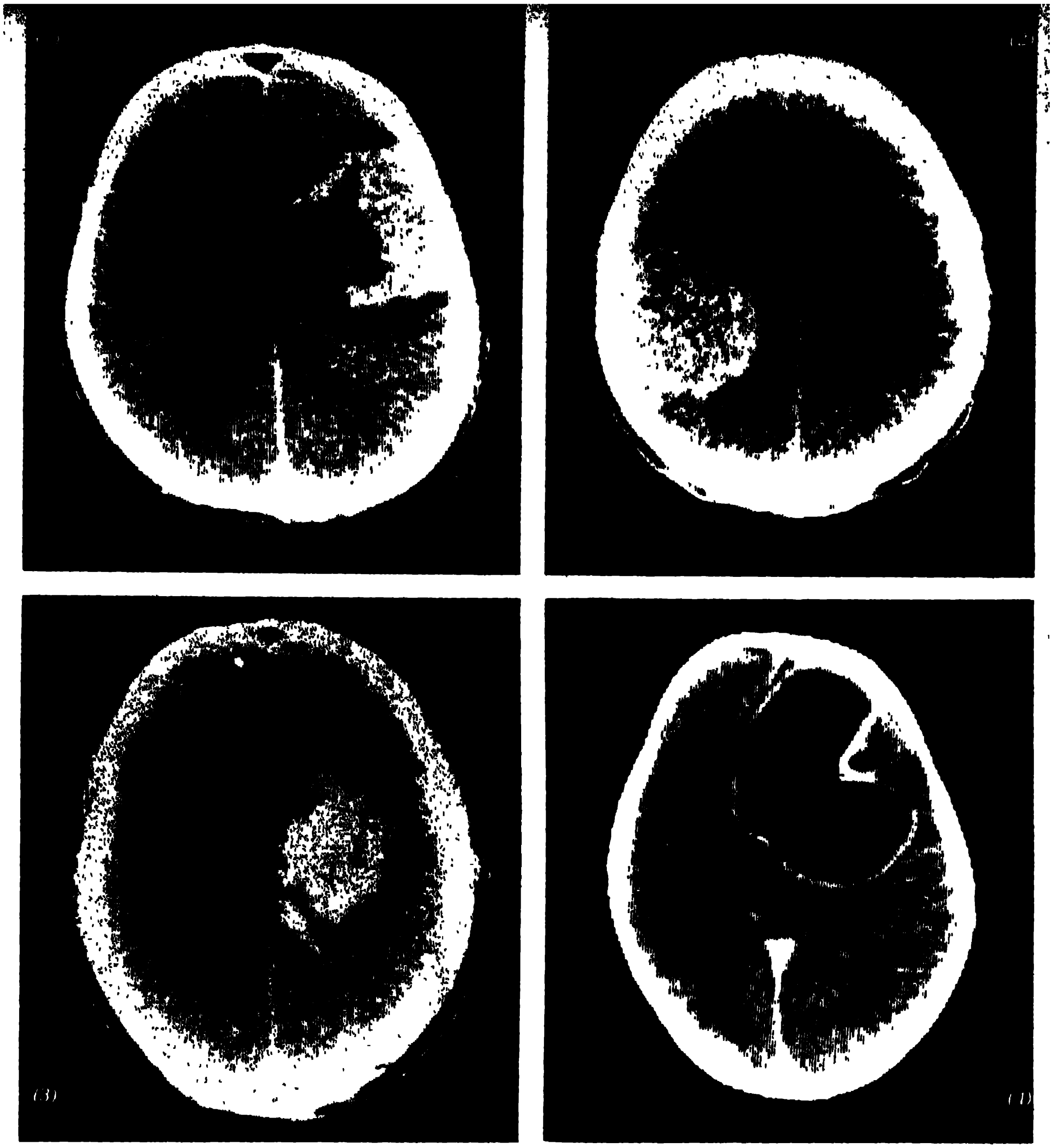
Doctor, some times we hear people dying of a brain tumour or brain hemorrhage Can they be easily diagnosed and treated in time? And I understand that the tumour, etc of the brain also produces headaches..

The various types of headaches I just described to you are not at all life threatening and can be treated with appropriate medicines, tranquillisers, etc In looking for the cause of recurrent and chronic headaches, a patient should be investigated for the status of his cardio vascular and renal systems, too In brain tumour, a headache is an outstanding symptom It tends to be deep-seated, non throbbing and aching or bursting Activity may provoke pain, while rest in bed diminishes its frequency The pain which awakens the patient from sleep at night or prevents sleep is more likely to have a demonstrable organic basis. In addition to headache, forceful vomiting may punctuate the illness in the late stage As the tumour grows the pain becomes more frequent and severe, visual disturbances, epilepsy, personality-, memory-, and speech-disturbances can also occur depending on the site and size of the tumour

Headache due to brain hemorrhage, on the other hand, is most intense and splitting and may or may not be followed by a coma In any case, such types of headaches, especially when occurring in young persons, and when associated with vomiting or temporary unconsciousness must be investigated

Doctor, how do you investigate these patients? Are there any safe and reliable and at the same time economical investigations?

Different possibilities of treatment are raised by a patient who presents himself for the first time with a severe headache and another one who has recurrent headaches over a period of months or years After having clinically examined a patient and forming an impression, a specialist usually asks for certain tests Apart from the routine blood and urine



CAT scan is the most advanced diagnostic aid for investigating brain abnormalities. Here the photographs of the scans of four common space-occupying lesions of the brain which cause headaches are shown: (1) malignant brain tumour; (2) benign tumour; (3) hemorrhage; and (4) abscess in the brain

tests, X-rays of the chest and skull are taken. These may or may not throw any light on the disease process

However, the most harmless and conclusive test is the CAT whereby a computerised scan of the brain is obtained This test excludes the possibility of a tumour, etc, or helps a doctor conclude about the size, shape, site and type of a brain tumour or brain hemorrhage Even degeneration or lack of blood supply to any part (or parts) of the brain or accumulation of water (fluids) in the brain are spotted by the CAT In other words, a specialist can arrive at a correct and accurate diagnosis by looking at the scan.

The most important thing to us is relief from suffering. Does the treatment of headaches leave any disability?

The most important step in the treatment of headache is to uncover and remove the underlying disease or functional disturbance For example, in the case of the common, everyday headache due to fatigue or tension, it's simple enough to advise avoidance of any offending activity, alcohol, and tobacco, and symptomatic therapy can be given For migraine, cluster headaches and tension headaches, too, symptomatic treatment is given And these headaches are not fatal It is brain tumour, hemorrhage, meningitis, etc which need drastic treatment Most of these cases require surgery Depending on the type (benign or malignant) and the situation of the tumour or hemorrhage, a specialist can tell whether the operation is going to be fatal, or whether it will leave any disability A brain tumour if not adequately (treated) is certainly going to be fatal

And now that I have already examined you, I feel that your headache is likely to be due to uncontrolled high blood pressure. I will want certain investigations done before we start treatment

V.R. Parikh

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LEARNING TO THINK

IN a recent novel, a computer takes over the office of the President of USA. The fear that the machines we are building today may rule over us tomorrow is prevalent among many people. Indeed, even among computer scientists, who are involved in the making of "intelligent" machines, there is a raging debate about the advisability of such efforts. The brunt of the attack is on that branch of computer science known as **artificial intelligence** (AI) or **machine intelligence**.

But, why all this fuss? After all, we know that the computer is only a machine, and does exactly what it is told and little else. Then, where is the question of a computer acquiring *intelligence?* How can a machine *think?*

The issue is philosophical and there are no clear-cut answers to these questions. We know little about the human brain, and even less about its thought processes. There is not even a consensus on what intelligence really means (SCIENCE TODAY, Nov. 1984) Hence, one justification for attempting to model intelligence can be that it may lead to a better understanding of the human mind itself

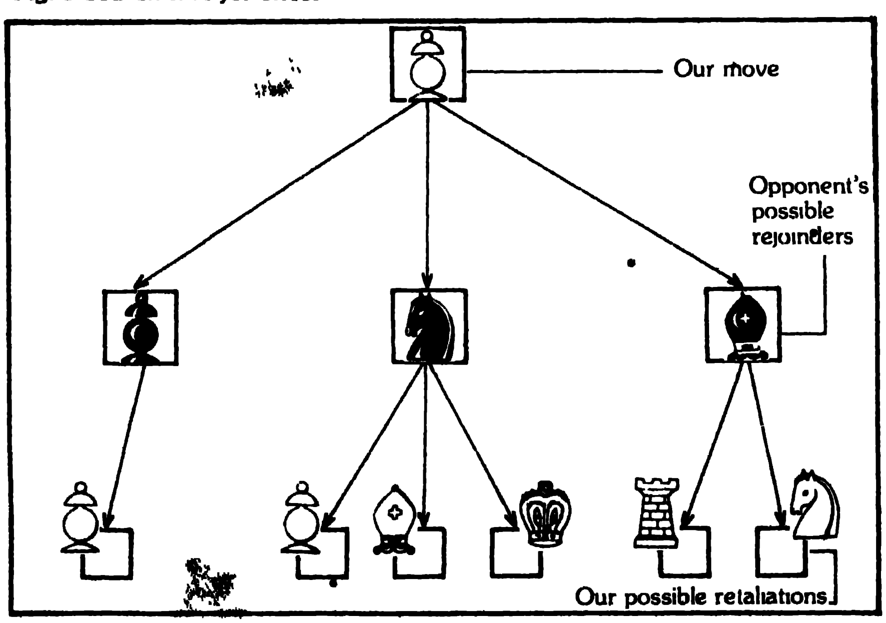
On the other hand, we can choose to ignore human behaviour, define intelligence in whatever way is convenient (say by/IQ tests or by the ability to play some games) and only try to build machines which exhibit such intelligence. Intelligence is usually defined to be the ability to solve a problem in an unfamiliar situation, based on knowledge and learning from past experiences in familiar situations.

Search

How does one program computers to render them intelligent? Normally, when we write a program, we have an idea about the solution and instruct the computer accordingly. Can we ask a computer to solve a problem, even when we do not know how exactly to go about it? Yes, indeed, and it is this concept that essentially underlies the science of machine intelligence. We just inform the computer about all *possible* answers and make it **search** through them to find the correct answer. A computer, with its phenomenal speed and vast memory, is well equipped to do this job Intelligent performance of the program lies in guiding the search to achieve efficiency.

Blind search for solutions is almost never feasible. In a chess game, if you want to consider all possible alternatives at all times (including plans for many moves ahead—the opponent's as well as your own), you would have to consider about 10^{120} possibilities, looking through which would take billions of centuries even for the fastest computer on Earth. The clue to intelligent behaviour lies in searching in a highly selective way, exploring only alternatives with a good chance of winning

Fig. 1 Search tree for chess



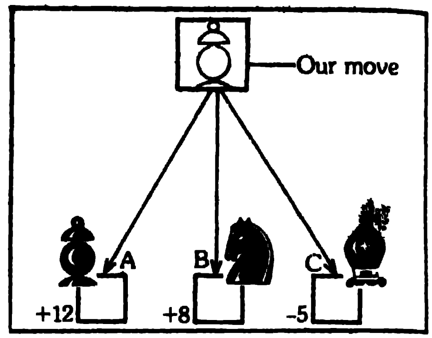


Fig. 2 Look-ahead

This is achieved by the use of **heuristics**. A heuristic is a rule-of thumb, a *stratagem*, an advice or any other way by which we drastically limit the search. A heuristic might work most of the time, but not always. This is as opposed to an *algorithm*, which is guaranteed to give the correct solution As an example of a heuristic, think of a chess novice, who only sticks to moves which protect the queen, regardless of other possibilities.

There are many aspects to a heuristically guided search:

(a) We have to choose an appropriate representation for the problem and the possible answers (called the **search space)** in such a way that facilitates search

(b) We have to **plan** or organise search

(c) There may be many methods or search strategies and we have to make restricted use of the appropriate methods. This is achieved by recognising **patterns** in the search space and using them to decide on strategies

(d) Search should be directed in accord with earlier experience, which means that some kind of **learning** should be incorporated.

S. Arun-Kumar
R. Chandrasekar
Kamal Lodaya
Paritosh Pandya
R. Ramanujam

Search trees

Suppose we are writing a computer program to play chess(SCIENCE TODAY, Oct 1983).Every move of ours is chosen from a number of possible ones. For each of these, we need to anticipate the opponent's moves and plan a proper retaliation. This situation is depicted in figure 1, in the form of an inverted tree, with the root on top and branches moving downwards. Such **search trees** are commonly used in the study of artificial intelligence A solution would simply be a path in this tree from the root downwards, all the way to a point where we reach the goal.

But as we said earlier, considering all paths in the tree would take billions of centuries, so we should look for short-cuts. We can pick only those that are locally the most promising ones.This is called a **look-ahead** technique. For example, we may decide to analyse just three moves ahead. However, since such an analysis is not guaranteed to result in a win, we should be able to find at least the paths that are more likely to lead to a win. For this we need some way of *scoring* each move so that the one with a better score ensures greater chance of winning

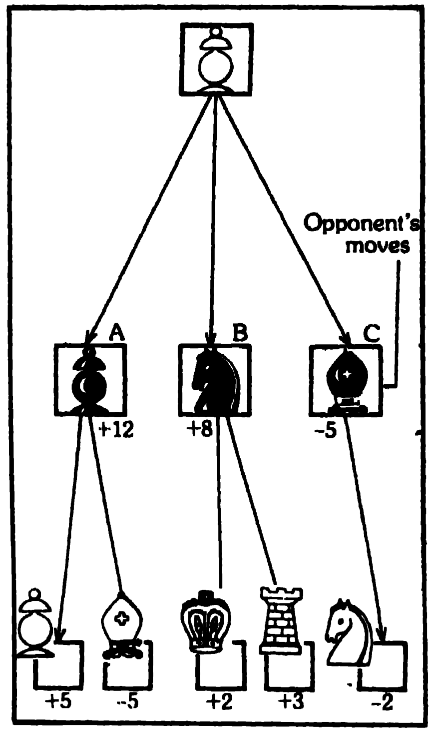
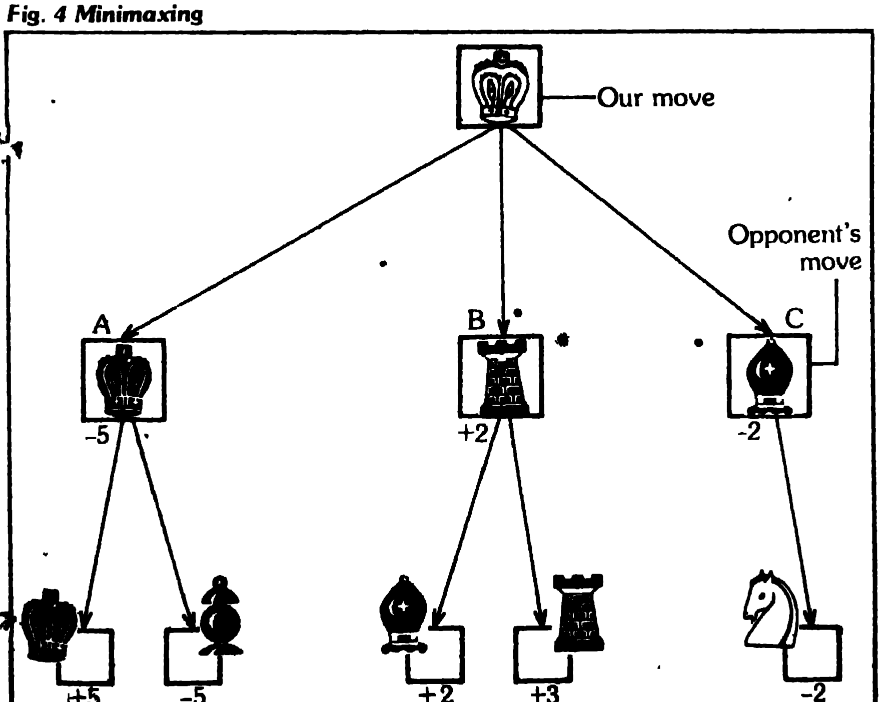


Fig. 3 Two-level look-ahead

Let us assume that on some basis we assign numerical scores to each possible move We assign positive scores for moves which help our win and negative ones for those that are favourable to our opponent. Then, we go on to choose the move with the maximum positive score. For example, if we have a situation as in figure 2, move A seems to be the best choice.

However, if we care to look a little further ahead, the situation may turn out to be very different (Fig.3).The opponent may choose the move resulting in -5. Now it looks as if we would have done better by choosing B, instead of A To take care of such pitfalls, we proceed as follows: assuming the lowest level scores,we proceed upwards. Whenever we consider the score for the opponent's moves, we carry up only the minimum, and for our own, we carry up the maximum score. This procedure is called **minimaxing**, and the new tree is drawn in figure 4. This can be done to as many levels of look-ahead as we please.

Fig. 4 Minimaxing



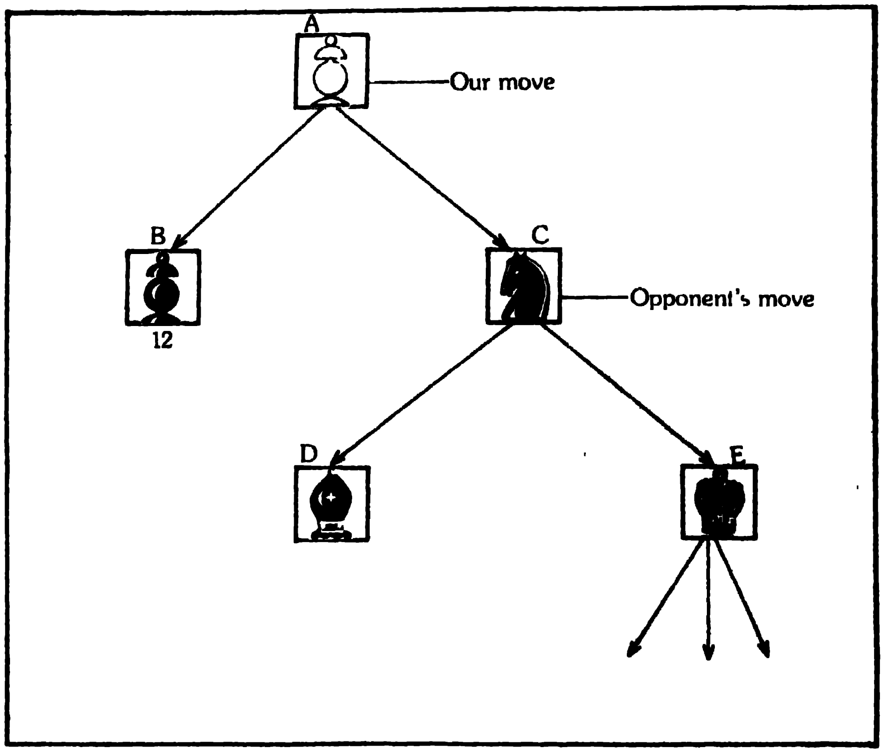


Fig. 5 'pruning' the tree

In fact, this paves the way for us even to discard whole chunks of possibilities in the tree For example, consider the situation in figure 5 The shaded portion in the figure may consist of millions of possibilities, but not one need be considered (As an exercise, the reader is advised to pause and figure out why The answer is given at the end of the article)

The main question that is yet to be answered is, how do we decide on the scores and how many levels of look-ahead are needed? This is where heuristics play a major role Since the number of alternatives is large at each point, with increasing levels of look-ahead, the total number increases exponentially This problem is referred to as *combinatorial explosion* Usually, not all alternatives are considered Some features of each move, like the king's safety, the defence of one's men and the attack of the opponent's men, are used to limit the number of alternatives. As for look-ahead, some moves are defined to be more crucial than others, and more look-ahead is done for these For scoring, factors like available strength, king defence, area control and mobility are used These heuristics are decided after studying several games of grandmasters Only after all this is put together, the program shows signs of intelligence.

Programming a robot

Apart from in science fiction, robots are now being used in industry as well, primarily in countries like the USA and Japan (SCIENCE TODAY, JULY 1984) We read about unmanned expeditions into space where robots perform experiments and collect data. Such robots perform complex jobs and exhibit to some extent, intelligence. For example, a moving robot can recognise an obstacle on the way and skirt around it. How does one program such robots?

If a robot were to search through all possible actions at every step the combinatorial explosion would ensure that no action would ever take place! The solution is to **plan** out its actions in such a way that the desired goal is achieved. At each instant, the robot studies its current situation and chooses an action which helps to minimise the difference between this and the required situation. This is called *means-ends analysis* Let us study this in some detail.

Assume that the robot is in a room where there are three boxes as in figure 6 Suppose we require the situation to be as in figure 7, where the boxes are stacked Further, we assume that there is extra space on the floor to keep the boxes temporarily. If the robot can take two commands

1 *go to place* x *from place* y
2 *take object* O from place y
to place z

we need to know two things before issuing these commands—when the command is valid (its preconditions) and the effects of carrying out the

Fig. 6

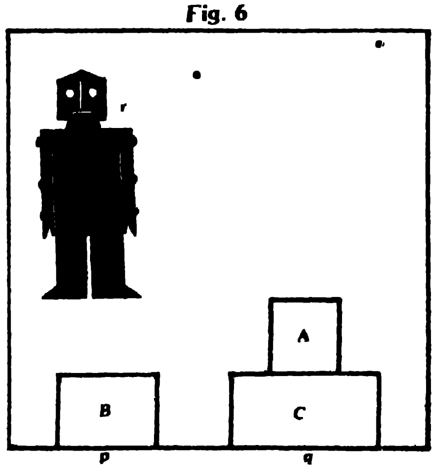
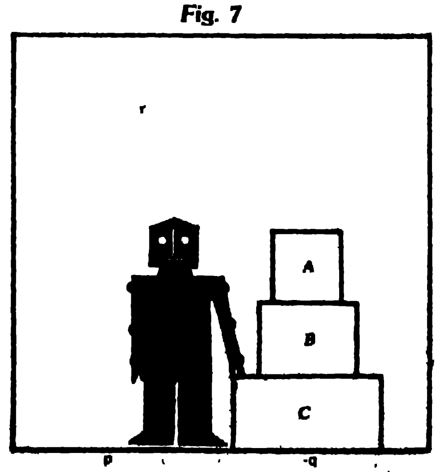


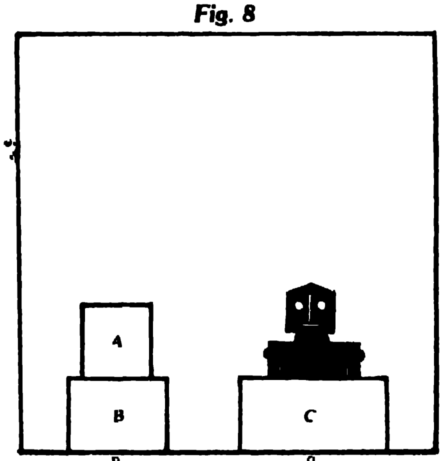
Fig. 7



command (its postconditions). The precondition for the first command is that the robot must be at x. Its post condition is, it is in y. For the second command, the precondition is that both robot and the object O are in place y and z is clear. The post-condition would be that both the robot and O are at z and y is clear. We assume that y is always different from z. We also have a set of initial conditions like "robot is at r", "box B is at p" which we call our **knowledge base**.

Applying the two commands one at a time we can arrive at the required situation (Fig. 8). But we have run into

Fig. 8



a problem here. We forgot that B should be on top of C. Now we cannot move B without shifting A. If we put it on C, we are back to square one, so the best thing is to put it down, which could have been done earlier. Intelligence is precisely the ability to reason out this way to avoid false starts like this. We need to have the robot make the necessary *inferences*.

Inference

Reasoning is the process of inferring conclusions from premises by applying what are called *inference rules* and using facts (called *axioms*). For example, "floor is clear" can be taken as an axiom, since some clear space is always available. An inference rule may be "A is on B" and "B is at x" implies "A is at x". One way of deducing a plan for the robot is to start with the final situation and work backwards, reasoning out at each step what needs to be done. The final situation here, is: "A is on B, B is on C, C is at q and the robot is at q."

Working backwards from this situation, we can think of a plan for the robot to do the job. We must remember that with each command executed the situation or the precondition changes. This way of working backwards is called *backward deduction* or *top-down reasoning*. A plan deduced this way is also shown in figure 9.

1. *go from* r *to* q
2. *take* A *from* q *to* s
3. *go from* s *to* p
4. *take* B *from* p *to* q
5. *go from* q *to* s
6. *take* A *from* s *to* q

Fig. 9

This should be contrasted with *forward deduction* or *bottom-up reasoning*, where we first derive all the possible conclusions we can from the given facts. These conclusions are again checked against the facts. Usually this becomes very inconvenient since our data base gets cluttered with lots of unnecessary details. Intelligence lies in remembering only those details which we need and ignoring the rest. An important task of artificial intelligence programs is to have heuristics to decide which details to "forget". We are also doing this, subconciously, all the time.

Induction

The kind of inference that we have talked about is deductive, where we infer facts from given facts according to certain laws. There is another type of inference which is fundamental to artificial intelligence called induction, the process of constructing general statements about events beyond recorded experience.

Look at the following pairs of words and fill in the blank:

REAL/SEAL, MEAT/NEAT, BORE/ —

How did you do it? You noticed a regularity in the pairs, namely, that the first letter of the second word is one later in the alphabet than the first letter of the first word in the pair. Using this rule you concluded that CORE must follow BORE. Thus detecting a *pattern* is central to performing any induction.

The general way of doing this is as follows: study a small part of the given facts, formulate a hypothesis, enlarge the small part and test the hypothesis if required, and repeat this process till all the facts are encompassed by the hypothesis. Then it becomes a rule. Of course, we may arrive at contradictions on the way and hence may have to look for a new hypothesis altogether. Such hypothetical reasoning is said to play a major role in human reasoning which is largely based upon analogies and similarities.

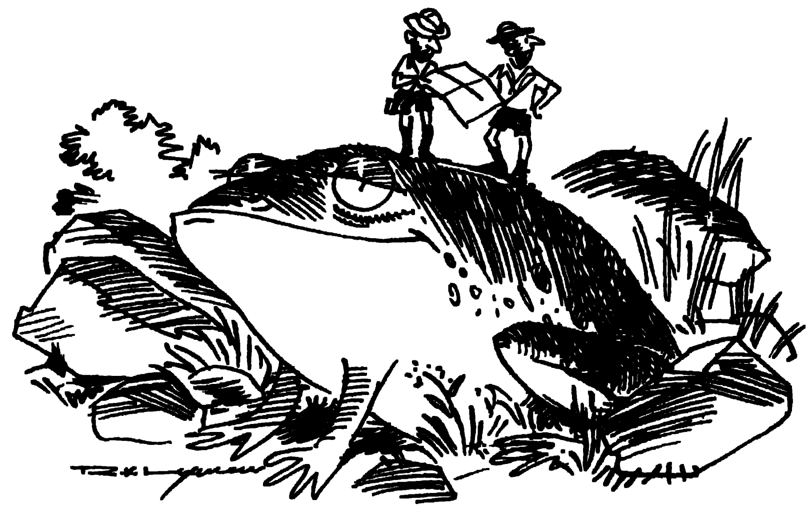
Inductive inference appears in artificial intelligence in many applications, the most important being **learning** and **pattern recognition**. When a chess program loses the game many times after the queen is lost, it should learn by induction that it is not wise to lose the queen. When a robot keeps hitting the wall, it should learn by induction that it cannot go through a wall. Pattern recognition is the general problem of studying a set of inputs and discovering the underlying rule of which they are instances. More about it later.

The Answer

Since the scores at D and E are as a result of the opponent's moves, the score at C is the minimum of those at D and E and hence some number less than or equal to 6. To get the score at A we need the maximum of B and C, which is clearly 12. Thus the score of A can be decided completely ignoring all patterns leading down from E, which can include a great number of possibilities.

Though our example is simple, this technique can be used in very sophisticated ways, called **alpha-beta pruning** in the literature.

The authors are visiting scientists at the National Centre for Software Development and Computing Techniques (NCSDCT), Tata Institute of Fundamental Research, Bombay



According to the report, this is the area where the giant frog was sighted!

[redacted]

The doctor prescribed this for your headache Dry all this thoroughly, pound it to a powder, mix water, make it into pills and take three, twice a day!

We don't know what it is yet We have put in some microchips and it's bound to do something when we press the button!

I have prevented the air pollution, Sir... I have plugged the smoking chimnies!

'Tic'kle your brains!

Vidya Dhar

SCIENTIFIC literature is replete with adjectives that have a 'tic' in it. And the variety can really have a hypnotic effect For there is 'static' which makes you stay still and take note while 'magnetic' attracts you with force. If 'elastic' stretches your imagination 'galactic' takes you on a grand tour of the universe. We list ten of these, to 'tic' kle your brains So play 'tic-tac-toe' with them. Answers on pages 70 and 71

1) **Adiabatic**:
   - A) Cured from diabetes
   - B) Without change in internal energy
   - C) Additionally effective in prevention

2) **Photosynthetic**:
   - A) Relating to trick photography
   - B) Concerning synthesis of chemical compounds with the help of light
   - C) Manufacturing by fibre optic technique

3) **Synaptic**:
   - A) Relating to the point of contact between two nerves
   - B) Synchronous
   - C) Artificially lighted

4) **Magmatic**:
   - A) Relating to mathematics
   - B) Nonmagnetic
   - C) Pertaining to molten rock

5) **Chemotactic**:
   - A) Movement influenced by a chemical agent
   - B) Strategy of chemical warfare
   - C) Balancing a chemical equation

6) **Pneumatic**:
   - A) Susceptible to pneumonia
   - B) Pertaining to or operated by air or another gas
   - C) Pertaining to the brain

7) **Aliphatic**:
   - A) Causing chaffed lips
   - B) Tendency to be fat
   - C) Organic compounds forming straight, long chains

8) **Holistic**:
   - A) Hollow and tubular
   - B) A system functionally greater than the sum of its parts
   - C) Arising out of a positron "hole"

9) **Astigmatic**:
   - A) Pertaining to the stigma
   - B) Antidote for asthma
   - C) A defect of vision

10) **Ballistic**:
   - A) Missile mechanics
   - B) Concerning the ballast
   - C) Resulting from a large bolus

A NEW MESON?

XPERIMENTAL observation of the peculiar break-ups of the weak quantum known as Z is causing lot of excitement in the camp of particle physicists. The break-up of the Z into a triplet of particles—electron, position and a light quantum—does not seem to square up with the theoretical expectations An interesting speculation is that these observations do not refer to the Z but instead to a heavy meson termed 'Zeta', which happens to lie near the Z

A couple of years ago the Super Proton Synchrotron (SPS) at Geneva has begun operating Two experimental groups working independently announced that the much-talked about carriers of weak force do indeed exist at the expected masses These are the charged quanta W ('W-plus' and 'W-minus' are antiparticles of each other) and the neutral quantum Z The unified theory of the weak and electromagnetic forces proposed by Glashow, Weinberg and Salam (for which they received the 1979 Nobel Prize) predicted the mass of W to be about 80 Gev and Z to be about 90 Gev (The unit of energy Gev, short for Giga-electron Volt, is about the mass of the hydrogen atom, through the Einstein's relation $E = Mc^2$)

Two experimental collaborations discovered the W's and the Z at the correct masses by searching for their disintegrations: W breaking up into an electron and an invisible neutrino (registered as some missing energy in the process), and Z by its decay into an electron-position pair

However, of the dozen examples of the Z as many as *one fourth* of them are found to have an energetic light quantum or photon emitted with the electron position pair Although such a process in which a photon accompanies the electron-positron pair is not taboo according to the known theoretical ideas, it should occur only once in a few hundred ordinary photonless events Thus the processes with the photon which are expected to be rare are observed to occur rather frequently

Many suggestions have been offered to explain the frequent occurence of these 'rare' events, with varying degrees of credibility The suggestion of the TIFR theorists, V Gupta and K V L Sarma, (*Physics Letters* **144B, 447**) is that these processes signal the decay of a new meson, which they call 'Zeta', whose mass is in the proximity of that of Z

A meson can be thought of as a bound system of a quark and an antiquark, the attractive force necessary to bind them is provided by a quantum called 'gluon' A quark is regarded as a point particle without any further structure. Until now there is no experimental evidence to indicate that the quark possesses any structure, i.e there is no evidence to say that the quark is, in turn, composed of some other smaller units.

However, it is possible that the quark is really not the ultimate constituent of matter but it has its own constituents called 'sub-quarks', which are, in turn, composed of still smaller entities, and so on, like the various layers of the "Cosmic Onion" In such a view, a quark can occasionally exist in a heavier state because of a different internal arrangement of the sub-quarks An "excited quark" once produced can form a new meson by combining with an ordinary antiquark The Zeta particle may be the least massive of such a new type of mesons Now the conjecture is that the Zeta may be responsbile for the observations which are at present attributed to the weak quantum Z.

In the coming months more data on the peculiar decays of Z are expected to be gathered by the experimenters working at the SPS accelerator in Switzerland It should then be possible to check whether the new forms of matter such as the postulated Zeta meson indeed exist in nature

K.V.L. Sarma

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Inherently safe reactors

T is well established that the risk posed by nuclear power reactors is lower than other sources of bulk power, and also much lower as compared with other sectors of industrial activity such as chemical industry, transportation, mining, etc Nevertheless efforts have been continuing to improve safety

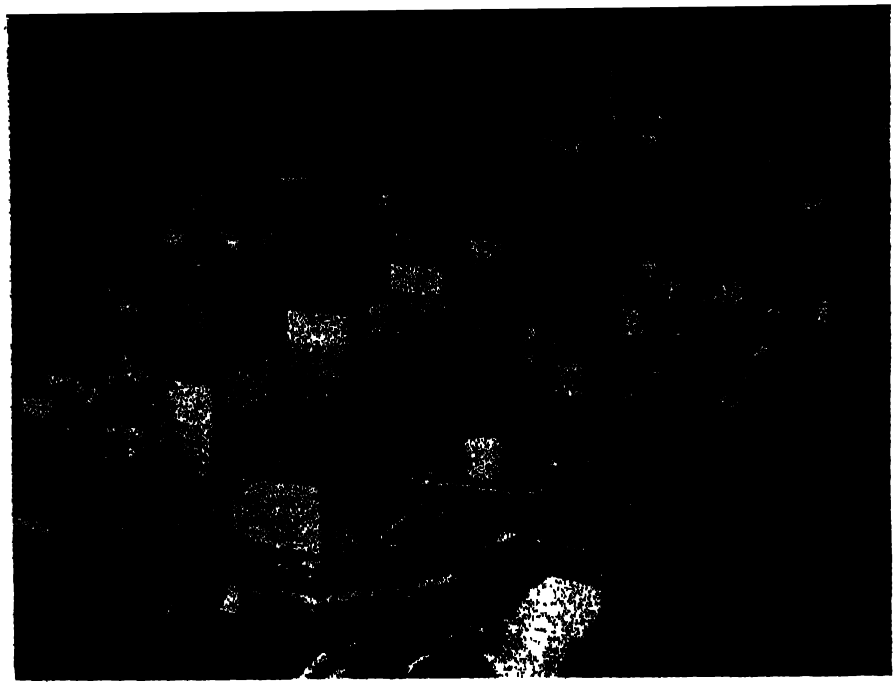
The most logical direction for these efforts has been to 'add-on' the so-called 'engineered safety features' which protect the reactor and also the environment By engineering a proper configuration of these highly reliable systems, it has been possible to achieve the high standards of safety with current designs of nuclear reactors To assure safety, a detailed safety analysis is performed of the reactor system for various postulated malfunctions, errors and events or failures that could arise within or outside the reactor plant For each of the cases considered, compliance with the criteria set by the regulatory body has to be demonstrated The review of this safety analysis is carried out by an independent set of experts

Over the years, the safety characteristics of reactor systems and the methods of carrying out the safety analysis have been continuously improved upon And with the current state of knowledge, it is possible to even quantify the risk and demonstrate it to be lower than other sectors of industrial activity

The question of public acceptance of this very important power source has not, however, been fully resolved in the western world which has already seen a very large growth of nuclear power—a sizeable fraction of their power needs is now derived from nuclear power Although the possibility of a failure has been shown to be acceptably low, the arguments for safety are not yet able to convince sufficiently some members of common public

It is in this context that the search for "inherently safe reactors" was started by some groups Institute for Energy Analysis, under the sponsorship of the U S Department of Energy convened a two day workshop in May 1980 Possibility of designing a practical inherently safe reactor was discussed by a group consisting of many of those responsible for setting nuclear energy on its present course The idea was to design reactors whose safety depends not on the intervention of humans or of electro-mechanical devices but on immutable and well understood laws of physics and chemistry

In an article (*Science* **224**, **1398**)" "Inherently safe reactors and a second nuclear era" the authors Alvin M. Weinberg and Irving Spiewak have described two such well-thought out ideas for the inherently safe reactor The first concept is the 'Process Inherent Ultimately



Safe, (PIUS) reactor being developed in Sweden by ASEA/ATOM, and the second one is the modular High Temperature Gas (HTG) reactor being developed in the US and Germany

For any reactor, safety depends on its ability to ensure safe shut-down at any time and to keep the reactor core cool. Reactors continue to generate substantial heat even after termination of the nuclear chain reaction This heat generation decays gradually

The PIUS reactor is essentially a 500-MWe PWR The reactor pressure vessel, the steam generators, primary cooling system pumps and interconnecting piping are all immersed in a large pool of borated water This water pool is maintained at full reactor pressure and is interconnected with the primary circuit of the reactor through pressure balance interfaces below the core and at the top of the vessel Any abnormality in maintaining the normal flow of primary circuit leads to entry of borated water from the pool into the primary circuit through the process of natural convection This achieves both shut-down of the nuclear chain reaction as well as removal of decay heat The quantity of water in the pool is sufficient to ensure cooling for at least a week in the absence of external source of water The protection against core melt down is achieved through passive physical principles without the intervention of active systems or reactor operators

Although the concept looks attractive, a number of technical problems must be resolved before adopting such a concept The stability of interfaces separating the primary coolant from the pool water is one of the most important areas of development of such a system

The modular HTGR is a 100 MWe graphite-core, gas-cooled reactor The inherent safety of this type of reactor is ensured by reactor's negative temperature coefficient which would terminate the chain reaction after a modest rise in temperature The power density in such a system is usually kept low and the geometrical configuration of the reactor is so adjusted that the decay heat could be conducted and radiated to the environment without overheating the fuel. Even here inherent safety is gained without operation of mechanical devices or intervention of operators. Some of the aspects of the HTG reactor have been demonstrated in the AVR reactor developed in Germany.(Fig 2)

A number of smaller research reactor designs have, in fact, been demonstrated to be inherently safe These reactors have been used in many parts of the world for research purposes by universities and similar institutions. Some of these reactors can be left unattended Slow-poke type reactors developed in Canada are most noteworthy among these reactors A larger version of this reactor can be used for district heating purpose in an unattended manner

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Doctoring genes of mice and men

Curing genetic diseases by gene therapy may soon turn out to be a reality, judging from the recent developments in recombinant DNA and genetic manipulation techniques These techniques will soon usher in a new era whereby some, if not all, inherited disorders will become manageable A beginning has been made in mice as reported by R E. Hamer and colleagues in *Nature* (**311**, 65) in a paper entitled 'Partial correction of murine hereditary growth disorder by germline incorporation of a new gene'

The authors have made clever use of a mutant strain of mice called little *(lit/lit)* where the animals are all dwarfs and the adults grow to only one half the size of the normal adults This strain of mice serves as a good model system for a human hereditary disorder (Type I) which involves deficiency of the human growth hormone In this disorder, though the gene for the growth hormone is present, the amount of mRNA (the messenger RNA specifies the protein) produced is less This results in low circulating levels of this hormome, with a concomitant decrease in the level of somatomedin hormone which influences the size to which an animal grows The authors microinjected a foreign gene, the rat growth hormone -- metallothionein fusion gene into the mutant eggs (*lit/lit*) Of the forty one mice, seven *lit/lit* mice carried the foreign gene The transgenic mice as they are called, in fact, grew as giants upon maturity Not only was the deficiency corrected but the animals grew larger

Breeding experiments with these transgenic mice established that the gene was stably integrated into one of the chromosomes and could also be genetically inherited However, the authors caution against overoptimism of the present technology to humans due to practical reasons Only one per cent of the injected eggs developed into mice that expressed the gene, in these type of experiments the integration site of the foreign DNA is unpredictable and many integrations may lead to new mutations In other words, it is not possible to replace mutant DNA sequences with normal sequemes Hence the mutant gene will not be eliminated from the gene pool and will probably segregate independently of the foriegn gene in the next generation These considerations, along with the fact that for most genetic diseases only one out of four offspring is at a risk, raise further doubts about application of this technology to humans

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LIQUID MAGNETS

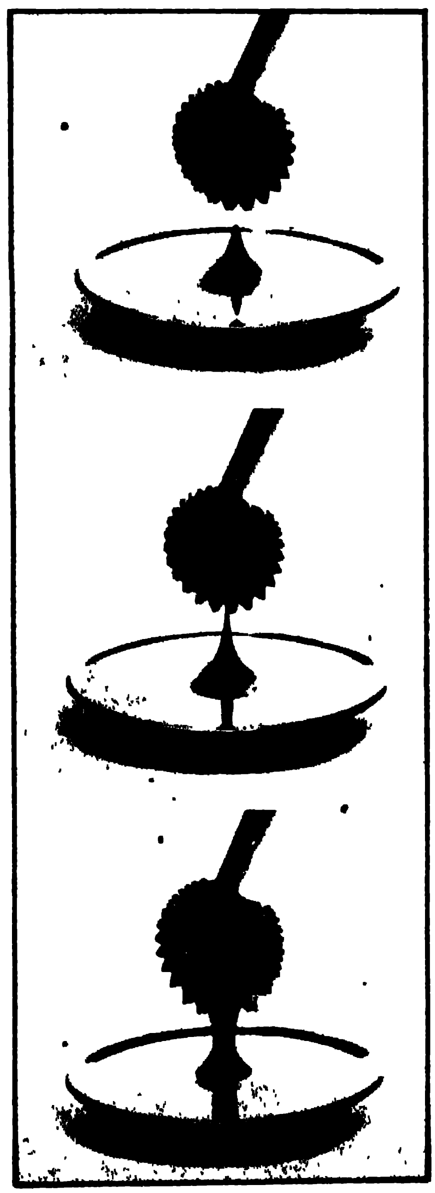
C. Manohar

The picture below shows a bar magnet held above a small quantity of liquid. The liquid has jumped up to meet the magnet half the way. This unusual liquid is a ferromagnetic fluid or for short, the ferrofluid. The ability of a ferrofluid to change its shape and flow in response to even weak magnetic fields makes it most interesting.

Normally, the mention of a magnet brings to our mind a solid thing in the shape of either a bar or a horse shoe which can attract tits and bits of iron. The bits of iron too are ferromagnetic but they are not permanent magnets. A ferromagnet consists of tiny regions, called domains, which consist of atomic magnets all aligned (the north poles of these point to one direction, with the south poles pointing in the opposite direction) within each domain. However, the different domains do not act coherently Each domain is surrounded by other domains which are oppositely magnetised and the net effect is to kill its own as well as its neighbors' magnetism. The permanent magnet, on the other hand, is more polished in its conduct Its magnetic domains reinforce each others' magnetism by aligning themselves parallel Thus it is able to attract other objects made of iron (Fig 1)

Though the solid magnets have been known for long, it is only recently that the possibility of having liquid magnets was realised The history of magnetic liquids forms a classic example of a spin off process from the space science. In the early days of the US space programme, NASA faced a problem: how to feed fuel to an engine in zero gravity conditions—where the liquid doesn't know which way is "down" so that it could flow down! A scientist hit upon a novel idea, impart magnetic property to the fuel and draw it into the engine by using magnetic force This, however, was not implemented but the idea of magnetic fluid was planted An entirely new technology, based on this, was to take firm roots later

How does one make a magnetic liquid at all? An obvious answer seems to be to melt a solid magnet. But, unfortunately, the magnetic domains are destroyed much before the solid magnet melts—the forces that bind the atoms into a solid are much too stronger than those which are responsible for creating magnetic domains. The solution to this problem is to grind a ferromagnet into fine powder and disperse it into a liquid. The commercialy available ferrofluids consist of very fine particles of either ferrite or any other ferromagnetic



material (with diameters of the order of 100 angstroms) dispersed in a suitable liquid such as water, kerosene and vacuum oil. Each of the suspended particle is approximately the size of one domain existing in the solid. These tiny pieces are uniformly dispersed by the constant bumping (Brownian motion) of the water or other molecules present in the medium There would be a tendency for these particles to coalesce into bigger particles when they become too heavy to be kept in suspension at which stage these heavy particles sediment Preventing this coalescence represents the main hurdle in the development of ferrofluids. The trick used for keeping these particles from coming together consists in coating them with suitably chosen long chain molecules like a surfactant oleic acid. The surfactant oleic acid used for coating, is shown in figures 2 and 3. When two coated particles approach each other, the surfactant molecules which were moving freely unitl now feel restricted (Fig. 4). The conformations which the surfactant molecule can assume tend to be limited, resulting in a repulsion Briefly, these surfactant molecules on the surface of the particle, act like tiny springs and push the other particles which come too close, preventing, coalescence. A proper choice of the surfactant and an evaluation of the stability of the suspension are the ma[illegible] problems encountered in the making of ferrofluids. It is now possible to prepare dispersions which are stable for years without losing their proper ties Normally, in a ferrofluid, one has about 10^{17} to 10^{18} particles per cubic centimetre of the fluid

A typical preparation of ferrofluid would consist in grinding ferrite particles, mixed with a suitable solvent like kerosene, along with oleic acid The grinding would continue for several hours—perhaps a week! The grinding is completed when the magnetic particles become a "part" of the liquid medium. This is easily tested by bringing a magnet close to the surface of the liquid. If the liquid jumps up to meet the magnet then, it indeed

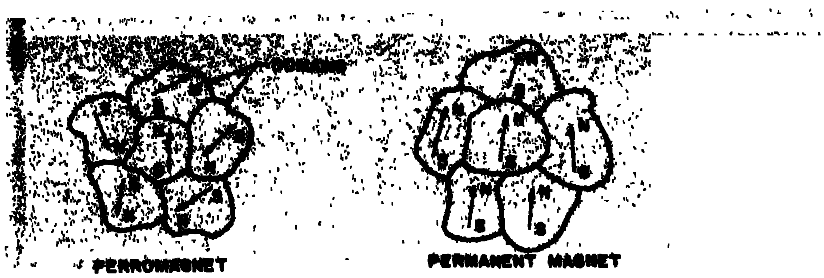


Fig. 1

is a ferrofluid. At this stage, the particles which are attracted, drag the liquid along with them to the magnet. If the fluid is stable, the viscosity of this dispersion remains constant with time

Commercial applications

The main interest in the ferrofluids stems from the several attractive applications, some of which have already been marketed Most of the applications result from the ability of the ferrofluid to move to a point where the magnetic field is maximum and remain confined there One of the first applications to enter the market, in a big way, is the Ferrofluidic seal developed by the Ferrofluid Corporation of USA. The basic idea of the seal is shown in figure 5. The shaft S rotates with one end in vacuum and the other at the atmospheric pressure The pressure difference is maintained by a small amount of ferrofluid in the tiny gap between the shaft and the support The support is made of a permanent magnet which holds the liquid in position. This ferrofluid provides a zero leak seal with no tear, as there is no mechanical contact between the magnet and the shaft The extent of the pressure difference that can be maintained depends on the properties such as magnetisation, viscosity and rate of evaporation Manufacturers claim successful operation at speeds in the order of 10,000 RPM (revolutions per minute) without a trace of leakage against a pressure difference of several atmospheres. Such seals are useful, for instance, in an x-ray tube with a rotating anode The anode, here, is housed in a vacuum and the electrons hit the anode with great force to generate x-rays. The point where the electrons hit become the hot spot in the anode and the life of the anode is reduced In order to circumvent this problem the anode is sealed with a ferrofluid and rotated from outside so that no hot spots develop. In general, the ferrofluid seals are useful in vacuum technology. These seals are also emerging as exclusion devices to exclude moisture, corrosive gases and other environments from sensitive parts of the machinery. A typical example being its use in magnetic storage disks in computers These disks rotate at high speeds with the read/write head just at one micron distance from the disk. Any contaminant such as hair or dust can damage the disk. A ferrofluid seal makes a near perfect dust free environment possible Often, ferrofluids can be formulated to withstand highly corrosive conditions (vapours such as HCl). These are used in chemical reactors along with the shafts used for mixing the chemicals. The ferrofluids seal off the corrosive atmosphere, from the environment

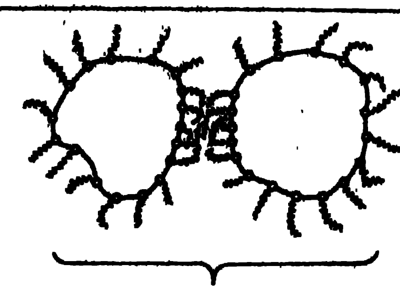
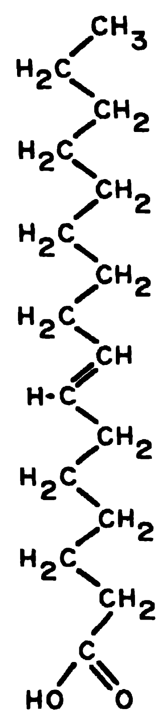
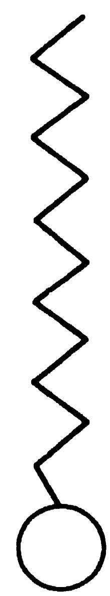


Fig. 4



OLEICACID.

Fig. 2



SURFACTANT

Fig. 3

Another type of use of liquid magnets is as dampers, for instance, in loud speakers. The principle behind this application is shown in figure 6. The conventional loud speakers consist of a cone with a coil attached to the tip of the cone This coil moves in between a magnetic pole piece in a narrow gap as shown. This cone has a natural frequency of its own and therefore responds abnormally strongly to any input signal of the same frequency. This effect mars the fidelity crucial in the loud speakers. A small amount of the right ferrofluid sitting in the gap between the coil and the magnet, as though the gap was made for it, damps any spurious resonances improving greatly the fidelity of the sound A big bonus arising out of this small change in design is the improved thermal contact between the coil and the magnet The heat generated is

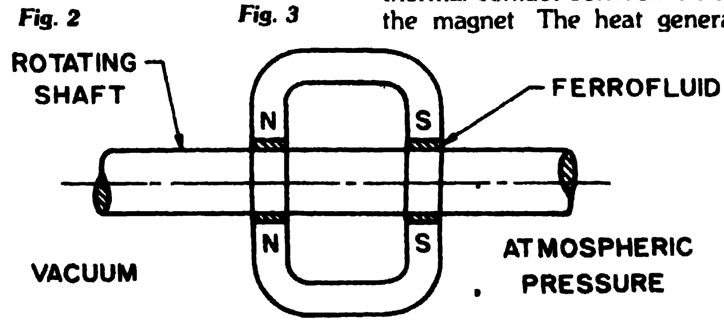


Fig. 5

dissipated much faster from the coil allowing the speaker to operate at much higher power levels. For a typical power input of only 3 watts, the temperature of the coil is 8°C above that of the magnet with the ferrofluid inserted, while in the absence of this ferrofluid the corresponding rise would be 50°C! Manufacturers also noticed that the ferrofluid provided a small centering force keeping the coil away from the solid walls of the air gap This force was sufficient to convert some of the reject speaker drivers into useful ones Without the ferrofluid the voice coil would rub which is prevented by the ferrofluid. The ferrofluid as a damper has been found useful in stepper motors also Here the ferrofluid is inserted between the stator and the rotor This facilitates the stepwise rotations to follow the voltage without overshooting.

Numerous other applications have emerged for the use of ferrofluids—flowmeters, viscometers, pressure transducers and ink-jet printing valves Apart from engineering applications the ferrofluids are also considered for applications in surgery The ferrofluid can be injected in a vein and held in a proper position by a magnet to prevent blood loss during surgery However, the toxic effects of these liquids have yet to be evaluated

In dilute solutions the ferrofluids are transparent. Their optical properties, such as refractive index, are a strong function of the magnetic field This is expected to lead to the development of magneto-optic devices in future

A new science

The ferrofluids are to be regarded as a new kind of fluids whose flow properties are like ordinary fluids in the absence of a magnetic field Their properties can be controlled and altered to suit our needs by externally applied magnetic fields This has given rise to a new branch of science, the hydrodynamics of ferrofluids The varied shapes assumed by the ferrofluid surface in the presence of currents and the magnetic fields are most interesting and throw a challenge

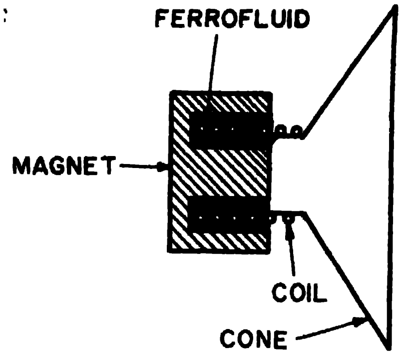


Fig. 6

to the theoretical scientists (figs 7a and 7b) Figure 7a shows a wire standing in the middle of a bowl containing the ferrofluid with no current in the wire. Figure 7b shows the same thing with a current carrying wire One can see that the ferrofluid

a *Fig.7* b

starts climbing the wire, being pulled by the magnetic field surrounding the wire The height to which it rises and the shape of the surface depends on the nature of the ferrofluid and the current carried in the wire. When a magnet is brought close to the surface of a ferrofluid, the surface instabilities that develop are really startling. The regular geometric patterns that develop are most interesting for the theorist.

Ferrofluids have interesting structures which are just beginning to be probed. The tiny magnetic particles join up into structures like strings and loops which are continuously changing from one to another. These structures change when a magnetic field is applied and thus give rise to structural chages within the fluid. The dependence of these structures on number, size, temperature, magnetic field, viscosity and flow rate form some of the challenging problems in statistical mechanics The existence of such structures is just beginning to be probed using powerful techniques like neutron scattering It looks as though they resemble polymer solutions, structurally.

To sum up, the field of ferrofluids is an emerging area offering a number of applications as well as challenges.

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From shaman to specialist

HE renowned Italian dramatist Ugo Betti who was a judge by profession once wrote, "Everyone has, inside himself what shall I call it? A piece of good news! Everyone is . a very great, very important character " Well said, Judge Betti But "important" as compared to what?* And even the optimistic Mr Betti would agree that although each one of us has a unique life experience, not everyone of us can effectively convey that "importance of being someone" to our fellow beings There are diarists and diarists but only one Samuel Pepys or Virginia Woolfe Similarly there are essayists and essayists (remember the English composition class?) but only one E B White or Lewis Thomas

To my mind the achievement of Lewis Thomas is the one more remarkable For, by profession, he is a scientist and not a scribe He is known for his research in immunology, microbiology and pathology He has also been a top administrator in several of the most important medical institutions in the United States dean of the School of Medicine at New York University and later at Yale, which he left in 1973 to become the president and chief executive officer of the Memorial Sloan Kettering Cancer Centre He is now also a professor at the State University of New York at Stony Brook These are credentials dazzling enough But they would still not be sufficient to earn for Thomas the kind of recognition and following he enjoys today His writings have brought him that

In the early 1970s Dr Thomas began to write essays for *The New England Journal of Medicine* under prodding from its redoubtable editor, Franze Ingelberger (who was Thomas's Senior at the Boston City Hospital during internship) Says Thomas "I had not written anything for fun since medical school and a couple of years thereafter, except for occasional light verse and once in a while a serious but not a very clear or very good poem Good bad verse was what I was pretty good at The only other writing I'd done was scientific papers, around two hundred of them " Thomas's essays, which were written for something over four years, were collected in a National Book Award winning *The Lives of a Cell* In 1979 came *The Medusa and the Snail* These were notes (and more notes) of a biology watcher (as the subtitles proclaimed) They were engaging discursions on a wide variety of topics warts, cloning, Montaigne and Medusa (the jellyfish, not the madam from Greek myths who could turn anyone seeing her face into stone!)

The book under review,• *The Youngest Science*, is subtitled *Notes of a medicine watcher* It tells the absorbing story of Lewis's professional life His father was a doctor, a GP who was very successful Dr Thomas Senior was skeptical about the healing abilities of the doctors of his day To be sure, there *were* enormous prescriptions written in Latin to "heighten the mystery The purpose of this kind of therapy was essentially reassurance A skilled, experienced physician might have dozens of different formulations in his memory, ready for writing out in flawless detail at a moment's notice, but all he could have predicted about them with any degree of certainty were the variations in the degree of bitterness of taste, the colour, the taste and the likely effects of the concentrations of alchohol used as solvent They were placebos, and they had been the principal mainstay of medicine, the sole technology, for so long a time—millennia—that they had the incantory power of religious ritual "

Dr Thomas Senior's "long disenchantment with medical therapy was gradually replaced by an interest in surgery, for which he found himself endowed with special talent Years later, after his death, I was told by some his younger colleagues that his opinion was especially valued, and widely sought throughout the country, because of his known reluctance to operate on a patient until he was entirely convinced that the operation was absolutely necessary His income must have suffered because of this, but his reputation was solidly established "

The paragraph quoted above would have gladdened the heart of a critic of modern medicine like Ivan Illich *(Iatrogenesis* or doctor/hospital induced disease is one of his iconoclastic concepts) But Dr Thomas Jr is too pragmatic too open minded (and poetic, too) about his profession to be miffed Indeed he himself would be sure to join Illich in searching for a remedy with which doctors might heal themselves

As he chronicles his professional life from student to Doctor and Dean, Thomas tells us about the epochal revolution in modern medicine which he witnessed (and participated in) The revolution in drugs, in technology and in knowledge which has come about in but a few decades past This has freed medicine from its earlier association with shamanism and magic And in that sense, medicine is *the youngest science*

The revolution goes on Somewhere along the way the computer, too, has joined man in the fight against disease But like the Camel who came to the Arab's tent, the computer is threatening to displace the human Long ago the healers and heralds of the gods themselves carried a white wand called Caduceus It had two serpents twined on it and represented the "opiate" power of the doctor That wand has been replaced by a stethoscope And today if you ask for Caduceus, you will be "accessed" to a computer programme by that name It offers the world's first diagnosis without doctors! Says Dr Thomas

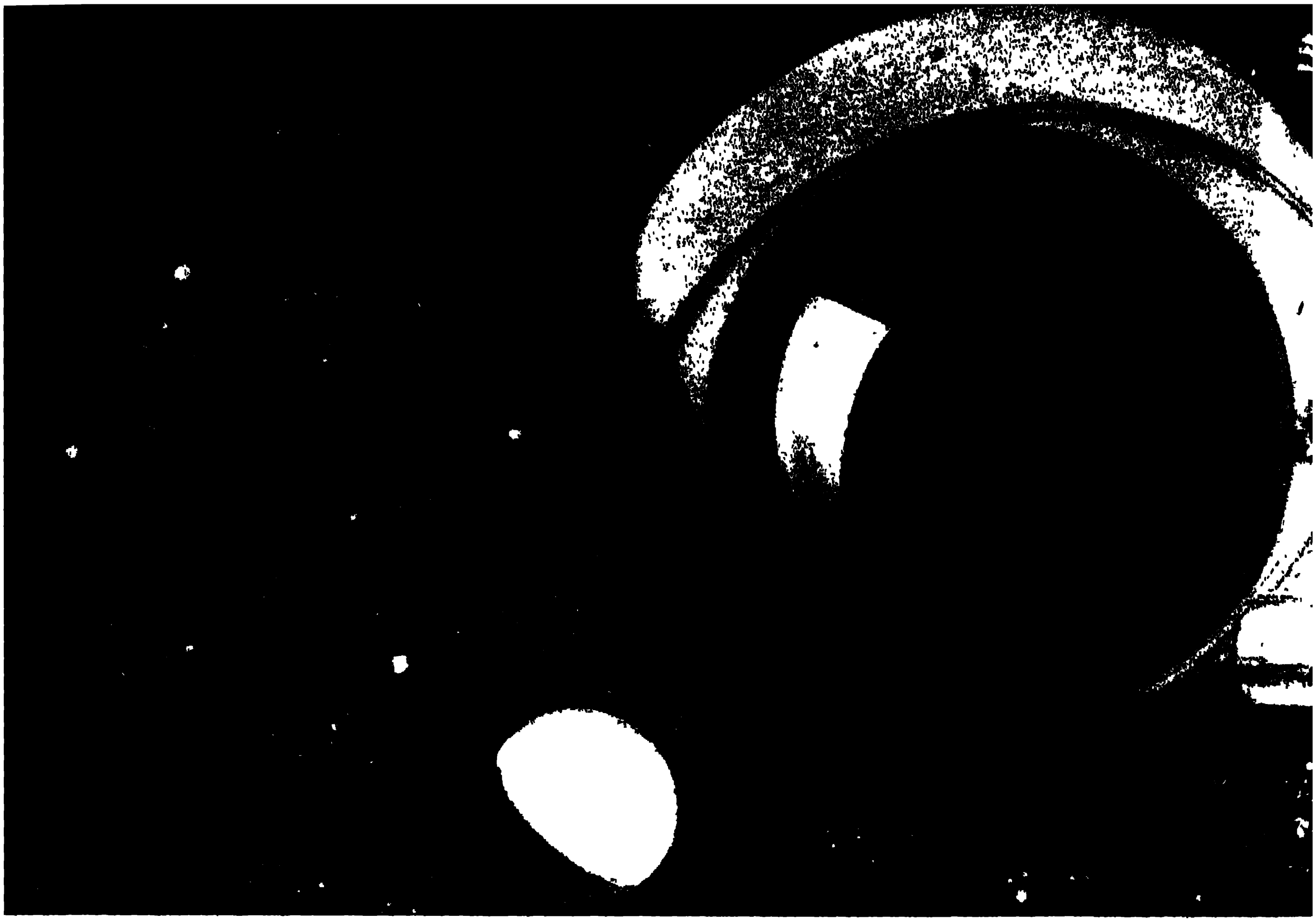
"Medicine was once the most respected of all the professions Today, when it possesses an array of technologies for treating (or curing) diseases which were simply beyond comprehension a few years ago, medicine is under attack for all sorts of reasons Doctors, critics say, are applied scientists, concerned only with the disease at hand but never with the patient as an individual, whole person They do not really listen They are unwilling or incapable of explaining things to sick people or their families They make mistakes in their risky technologies, hence the rapidly escalating cost of malpractice insurance They are accessible only in their offices in huge, alarming clinics or within the walls of terrifying hospitals The word 'dehumanising' is used as an epithet for the way they are trained, and for the way they practice The old art of medicine has been lost "

Well, no one can accuse Lewis Thomas of not explaining, of not caring or being indifferent It is a superb book one of the easiest (and most enjoyable) The only gripe is that having known Lewis as a doctor, one wants to know more about the man Perhaps he will write another autobiographical This one is third from a series sponsored by the Alfred P Sloan Foundation—books by distinguished scientists meant to make the process of scientific discovery more understandable, more real and more exciting to the general reader The first was by the physicist Freeman Dyson *(Disturbing the Universe)* and the second by the Nobel Laureate immunologist Peter Medawar *(Advice to a Young Scientist)*

Vithal C. Nadkarni

* "As compared to what?" was James Thurber's response to the question," How is your mother in law?"

• THE YOUNGEST SCIENCE—NOTES OF A MEDICINE WATCHER BY LEWIS THOMAS OXFORD £ 12 50



The Green Invaders

Jayant Narlikar

TOM Rohrich glanced at the dash board, and did a mental calculation — still thirty-seven long miles to El Paso. It is one thing to read in a geography text that Texas is a vast state, it is another to drive across it. Although in the past Tom had driven thousands of miles, today he felt the need for a companion to relieve the monotony of driving on a straight highway. Even the landscape offered no variation on the theme of vast, open spaces with hardly any human habitations.

For the last hour, the fatigue had become unbearable. He *had* to make it to El Paso before nightfall and the thought of food and rest must wait till then. But would he make it at all? He was becoming increasingly doubtful of his ability to concentrate on driving. Should he stop for a while and snatch a shut-eye for ten minutes? But what if he fell fast asleep and woke up too late?

The decision was made for him all of a sudden. He had failed to notice a small bend in the straight road and with a jerk he found himself on the soft shoulder of the highway. Tom declared himself temporarily unfit to drive and pulled to a stop by the road side.

The twilight sky to the west was full of glorious colours. Tom was reminded of the many "westerns" he had seen as a schoolbody — the heroes riding across vast open spaces into the sunset. It was hard to think that this was reality - that such places still existed on the Earth. Harder to believe if you have driven only the week before in downtown Manhattan during rush hour. Why not imagine that you have been transported to another planet? After all, Tom was a sci-fi fan! In that unearthly setting he let his imagination wander...

Spaceships of alien design...weird extraterrestrials..advanced supercivilizations...do they exist in reality? Or is man alone in this vast Universe, as Tom was alone in this vast but empty setting?

Suddenly Tom realized that he was not alone. On the western horizon he found a whitish spot. Could it be Venus setting after the Sun?...But the spot became bigger and bigger. To Tom's tired mind this seemed peculiar, until his brain rationalized whatever it was, was coming closer to him. How big was the "thing"?

For the first time in his life Tom realized the difficulty of assessing the absolute size of an object in an empty landscape. ... Was it an aeroplane in trouble preparing to crash-land? But then the altitude of the "thing" did not decrease— and as it came closer, it certainly did not resemble a plane.

As the thing approached Tom became conscious of a strange sound—sound that

became increasingly unbearable to his ears. Tom got into the car and turned up all the windows The volume of the sound dropped, but as Tom realized it was not the volume but the shrillness that was bothering him

His last conscious effort as he fell back in his seat was to search desperately for some paper tissues to plug his ears with. . .

When Shiva got down from the State Transport bus and made his way to his farm he was hardly in a position to walk His day in Satara had begun well and after many months he had won unexpectedly in gambling Unfortunately he elected to convert all his liquid assets into a truly liquid form and drink them down.

Which is why when the conductor gently pushed him out of the bus at his village stop, Shiva decided to economize on walking He knew a shortcut that would save him a kilometre or so It was a shortcut he had often used before but only in board daylight Had he been sober, he would not have used it on a moonless night For, as all the village was convinced, that footpath was haunted

But tonight Shiva was not scared—the drinks had 'ensured' that He blundered along with the sole aim of getting to his farm as soon as possible

". . . . ." Shiva cursed softly as he blundered against something Who would come along this god-forsaken track at this time of the night?

Shiva was not kept in the dark on that count. There was a sudden flash of light and Shiva could see what or whom he had bumped into What he saw instantly made him sober

He had bumped into a man—but he was all green. And as Shiva watched, the person became illuminated and began to go skywards As Shiva raised his eyes to see where "it" was going he saw a spaceship of unusual appearance

Shiva was too scared to cry out in alarm His ears began to ache as he became aware of a strange sound coming from the direction of the spaceship

Then he knew no more

Nobody knew her real name: everyone called her Sister Maria She was a nun in a convent in Sicily. She was known to be deaf and dumb from the day she had been left as an orphan at the door of the convent But she communicated with others easily, with her fine handwriting and with the vivid pictures she could draw.

It was unusual for Maria, a shy and reserved girl, to seek an audience with Mother Superior. Maria had been out for a walk, as was her usual practice after the evening prayers, but today she seemed

very excited when she came back

"What is the matter, child?" asked Mother kindly She gave Maria a writing pad and a pencil

Maria had a lot to tell She drew a number of pictures and wrote a few lines

The Mother Superior looked at the sheets with growing incredulity But Maria was not known to be given to fancies There must be some truth behind what she saw and reported. What did it all signify?

The Mother clutched her cross as she questioned Maria further

The party was in full swing

Scientists from NASA's Goddard Space Flight Center and from the University of Maryland had gathered to give a send off to Roger Buckland from Goddard, at his apartment

Roger Buckland was regarded as an ace amongst the new generation of scientists brought up on NASA's space exploits like Skylabs, Spacelabs, the Shuttle....Indeed in a span of a decade he had achieved a reputation that made him the most sought-after scientist for any new project...And Roger was amongst the few who could afford to turn down an exciting project because of other commitments Whenever he took on a new assignment, Roger would mutter· "This is my last scientific project! After this I will have only golf and sailing" But his colleagues knew that this resolution would last only for a weekend Come Monday, and Roger would be back at his desk.

"I can make a safe bet, Roger, that this time we will see you back at work after a two month rest!" commented a colleague sipping a dry Martini He had no objections to send offs provided they were accompanied by parties

"But, John, suppose I don't come back at all from my assignment? What happens to your bet?" Roger asked with a twinkle in his eye

"No such luck for us! We are sure, you will be back like a yo-yo . .After all, space travel is perhaps the safest means of transport today "

"Yes, isn't it strange?" agreed another scientist." space travel is safer than air travel which is safer than travelling in your own car "

"And, taking the reasoning to its logical conclusion, the most dangerous mode of travel is on foot, crossing the street If you don't believe it, try crossing a street in Bombay," said Willy Bones who had just been back from a trip to India

Kumar Marathe, an ex-patriot from Bombay felt that it was his duty to clarify matters:" Willy, you forget one important thing! The zebra crossings in Bombay are for cosmetic purposes only No motorist will stop to give way to a pedestrian crossing them You illiterate westerners don't know this simple fact "

While everybody joined in the laughter, Bones was quick to notice that Roger was not his usual jolly self. Willy Bones was not a scientist; he was at the party because he happened to be staying with Roger But observing people was part of Willy's business.....

The party was over and the last guest departed by two a.m Roger loaded the dishwasher with ten soiled glasses and returned the bottles to the crate

"Black or white?" Willy had not been idle He had prepared coffee which he knew would be welcome both to Roger and himself

"Black Thanks," Roger took the mug gratefully and reclined on the sofa

Willy took the rocking chair Taking a sip of the black brew, he leaned back and then asked the question he had long meant to ask

"Now, Roger, tell me Why does a space scientist need the help of an F B I agent?"

There was a few moments silence as Roger quietly sipped his coffee. He seemed to be at a loss as to how to begin his answer Willy waited patiently At last

"Willy, you know that today's party was my way of saying 'good bye' to my colleagues as I depart on my space mission "

"But that is nothing new! I could see, even as an outsider, that they are treating it as an 'au revoir rather than as a 'good-bye' After all, it is not your first trip "

"True, but I am convinced that this will be my last trip " Seeing the look of polite incredulity on Willy's face, Roger got up, opened a drawer in his desk and dumped a pile of papers in front of Willy

Willy opened the bundle and found that it contained newspaper cuttings 'Flying saucers sighted in Texas' 'indian villager confronted by flying green men' 'Italian nun visited by angels. . ."

"Since when did you start attaching credence to such nonsense?" Willy Bones knew that his boyhood friend had a healthy skepticism for flying saucers and other paranormal phenomena

But Roger was serious "Willy, I know that you know that I do not believe in such unconfirmed news reports On many occasions in the past I have publicly refuted claims made by cranks that they have seen or visited extraterrestrial creatures."

"I know, Roger; but....."

Roger was, however, too excited to let Willy continue

"The whole flying saucer mania started back in 1947 when an amateur aeroplane pilot Kenneth Arnold claimed to have seen such disc shaped objects following his aircraft.....This started the avalanche of claims...."

Willy managed to get in a sentence as Roger paused to sip his coffee."I know; but these claims were investigated and refuted by scientists..."

"Exactly Project Blue Book, Project Sign.....there are so many detailed investigations. And what did they reveal? .....Nothing! Nothing, that is, to support the original claim that an 'Unidentified Flying Object' (UFO) was of alien origin People often mistake planet Venus for a UFO They may even have seen man-made aircrafts or spacecrafts .Some are misled by optical illusions Some are mentally disturbed and unreliable witnesses.... And the worst of the lot are witnesses who fabricate the so - called evidence.

"Yes, Roger, I have followed this controversy as a layman and I entirely agree with you Which is why I am surprised that you take these reports seriously," continued Bones, now firmly determined to get a word in edgeways "Take this Texas incident, for example The witness has admitted that he was very tired and mentally not very alert. This Indian villager was plainly drunk....As regards Sister Maria I do not know her previous record of credibility...The same problems of credibility arise when you look at these reports from Mexico, Cambodia....and Australia Obviously there is more to it than meets the eye, since you are showing me all this "

"Willy, you are right None of these reports or witnesses are convincing They wouldn't stand up to a legal cross examination But there is more to it."

Roger went to his desk again and from a locked drawer took out an envelope marked 'TOP SECRET' He opened it and brought out a photograph.

Willy studied the photograph first with his naked eyes and then through a magnifying glass he carried in his pocket Roger was watching him with amusement mixed with expectation.

The expected reaction came Willy whistled. Roger continued, "What you see

through your magnifying glass has been inspected by us with a computeraided thousandfold magnification But you must have got the gist of the picture "

"Where did you acquire this picture?"

"The picture was transmitted by my colleague Dick Frost who took it while on a space mission Probably this was the last act in his life, for we do not know what happened to him or his spacecraft."

"But come! You can't lose a spacecraft with no one knowing about it I don't recall reading about the incident," Willy was clearly surprised Roger nodded

"I should not be telling you all this classified stuff! But that was the fourth spaceship we lost. The first one belonged to the military, the second to the C I A and the third contained scientific experiments Frost was sent to find out why the third one was lost He had instructions to transmit TV pictures of anything unusual he saw The photo transmission could be done automatically on pressing an emergency button, in case the observer was incapacitated....

"And this is what happened Frost had about five seconds of acting under free will He pressed the button while trying to transmit a verbal message The button produced nearly a hundred picture frames like this one " Roger concluded

"And the message? What did Frost say?" Willy asked expectantly

"Willy, you asked me what a scientist wanted with an F B I investigator. Well, here is your answer Frost's last and only words were

'Spaceship...with green men coming out...but..?'"

Willy lit his pipe It was an elaborate ritual for him which came in useful when he wanted time to think After he had completed the ritual and blown a couple of exploratory smoke rings in the air, he spoke

"What is the reputation of this man, Frost? Is he given to fancies?"

"It would be more appropriate to use the past tense, for I cannot imagine that he has survived this long, wherever he went... No, I cannot call him fanciful If at all, he was a dour, down-to-Earth type of man Did as he was told very efficiently But we never expected new ideas from him " Roger explained.

"In a free society like ours you cannot keep these accidents secret, much longer It will give ammunition to Senator Blackman," Willy spoke with a wry smile

Senator Blackman was a great advocate of UFOs being examples of alien intervention Alien, that is, from beyond the Earth He always accused the scientists of pushing evidence under the carpet with a deliberate view to misleading the public

"True! But as a last resort I am going on an investigative expedition to find out what happened to Frost I have five assistants on this trip If we also don't return...."

"Then the whole Pandora's box will have to be opened, Blackman or no Blackman," said Willy, "But Roger, what is your own interpretation of the episode?"

"Willy, I called you for advice because I cannot make anything of it These green men appear to be all over the Earth and also above its atmosphere Until the Frost episode I dismissed it all as the usual UFO nonsense But you saw the photograph It does show, unmistakably, little green men around a cigar shaped spaceship This picture is not an artist's impression drawn by a fanciful nun It is pure electronics that cannot be cheated Nor was Frost drunk or mentally fatigued His mental state as recorded in our ground based monitor was perfectly normal. ...No, what puzzles me Willy is Frost's final word 'but' Obviously he had some doubt about what he saw What was it?"

"Well any experience I have of down-to-Earth crime is at your disposal, Roger I will try to figure out something but, mind you, I don't hold out any hope Still, if I do have a brain wave where do I contact you?" Willy Bones took out his diary to jot down the information

"Here is a classified phone number," Roger gave him the number and continued "Call this number and ask for Mr B He is my boss, though I have never met him; nor do I know who he is But he will take suitable action in case you have any suggestions "

"Roger, I have one request to make," Willy glanced at the photograph Without a word Roger handed it to him

Willy returned home the next day, still no wiser about the green men. Like Roger he found it hard to believe that they were extraterrestrials But then how to discount the independent evidence collected from far corners of the world? Above all, how would one "explain away" Frost's photo?

He had heard of faked photographic evidence on UFOs, evidence which was subsequently debunked But here the photo was taken by NASA's own scientist and processed in the highly qualified laboratories of that organization. Certainly there was no room for doubting the authenticity of the picture

Nevertheless Willy decided to have a second opinion He could not seek it from his expert colleagues in the F B I, for the photograph was 'top secret' and he was not even supposed to have it So he decided to arrange an inspection privately by an expert who was a trusted friend.

George Baldwyn was the right person for this task An astronomer who extensively used electronic devices to elicit the last bit of information coming through the telescopes, about galaxies, quasars and what not, George would certainly help him out on this one Willy put in a long distance call to George's laboratory on the West Coast

"George! Willy Bones here...Hi to you. Listen, can you inspect a photograph for me? Its very urgent "

"All your demands are urgent Well, today I am going observing at Palomar, for two nights Then I am off on a hiking trip to Mexico "

"Forget the hiking part I will see you in L A in two days' time," Willy hung up so as not to give George any time to protest.

Willy made a rapid calculation Roger's mission was to leave from Cape Kennedy in ten days Two days would already be lost in George's observing programme That left eight days He needed one day to contact Mr B to inform him of his findings, assuming he had anything to report So he had barely a week in which to get at the facts

He met a sleepy-eyed George in his lab two days later After the preliminary greetings and curses were over, Willy showed George the photo He had taken care to erase all the official stamps on the back

"Is this some kind of a joke You could print this photo in a sci-fi magazine," George complained.

"Well, see what you make of it! Is it science fiction or fact? Fake or real? A lot

hinges on this, George "

"This picture has been taken, not from an ordinary camera, but electronically Of course I don't have to tell you that! But there may well be more in it than meets the eye What exactly are you looking for?" George asked

"Wish I knew! Obviously you will have to examine every square millimetre of this picture minutely How long do you think it will take you?" Willy asked anxiously

"A week! May be less if I don't get my usual quota of sleep," said George

Willy smiled and produced a bottle of tablets

"These are guaranteed to reduce your urge to sleep by about fifty per cent You can make up for it after the job is done "

GEORGE was known to be a methodical person, but Willy was observing him in action for the first time. And he was surprised to see the high resolution that George's observing instruments achieved Willy was able to make out even the individual fingers of the green men in the picture

"Are there many such instruments in the world?" Willy asked with admiration

"I don't know of any other This one I made myself for my own use," George said in his matter of fact way

But with all the expertise at his command, George could not stop time ticking away Hours passed into days and soon Willy's prescribed week drew to a close But he could not get anything tangible from the photograph, something that could explain Frost's last 'but' Certainly he had nothing to report to Mr B.

The seventh day brought a small visitor to their lab He was George Junior the ten year-old son of George Baldywn. Junior was clever but highly curious He kept bombarding Willy with questions that he found hard to answer While there was a short pause, Willy slipped in his own question,"George Junior, I have a question for you Why have you come today and how long are you going to be around?"

"That makes two questions," replied Junior "I have come to help daddy and will wait till he finishes this job For, then I am going to take him hiking We are already a week behind schedule."

Towards the evening George finally finished his work He called Willy to the computer terminal and explained to him how to operate it "Now you can recall any part of the picture of the screen and enlarge it as much as the limits permit Whatever information I could extract, I have placed it on the tape Good luck!"

George left to freshen himself, and Willy felt a stab of disappointment. He knew that nothing remarkable would emerge from his study--wouldn't George have noticed it if there were something unusual? Still he began to operate the terminal, more in response to George Junior's queries than to find out anything on his own Soon Junior took over the terminal and began to move the different parts of the picture on to the screen with occasional remarks like "Wow!", "Are these green men real?" "What kind of ship is it?".....and so on

"Look that man is eating a hamburger," exclaimed George Junior suddenly "Wish I had one!"

"A typical American kid," thought Willy who detested hamburgers and other 'junk food'—until he realized the implications of Junior's remark

He rushed to the terminal and almost pushed Junior away "Where? Where did you see that?"

Junior pointed to one green man munching something like a sandwich He enlarged the particular part of the picture until the sandwich stood out clearly

"You can't fool me! I know a Big Mac when I see one,"said Junior complacently

"In that case, Junior, you have solved a big problem of mine You deserve not one Big Mac but two, if you are right,"Willy, for the first time during the week, felt elated

AS Willy reclined in his seat on the last flight from Los Angeles to Washington, D C, his mind ran through the events of the last three hours.....how George on his return from the bathroom was informed of his son's discovery, how he caught its significance and finally obtained a very high resolution picture of the sandwich which, Junior confirmed was indeed a Big Mac, how he telephoned Mr B and how a seat on this last flight was arranged for him even though the flight was full....

So the green men were not extraterrestrials They were Americans Were they "space jackers"— a new breed of hijackers employing highly trained scientists and holding governments to ransom? But then what were they doing all over the world? . .Perhaps Mr B could throw some light on this mystery

At Dallas Airport, he was met by a young man with a flowery tie, exactly as Mr B had told him on the phone

"I am Jonathan," he introduced himself.

"I am Willy."

"Let us go, Mr B is waiting," Jonathan took charge of Willy's luggage and led him to a dark limousine, with a uniformed chauffeur.

"A strange kind of a car!" Willy exclaimed as he got inside Although outsiders could see into the car, to him nothing was visible as the car sped through the expressway

"Mr B is a shy man He does not want it known where he works," Jonathan explained.

Willy knew the Washington area very well and tried to figure out the route When they joined the Beltway round the city they turned towards Virginia side After a few miles it made an exit along a small road which Willy could correctly guess But thereafter the chauffeur took so many turns back and forth that he finally gave up the car pulled up in an underground car park very close to the lift Jonathan hurriedly pulled Willy into the lift so as not to give him any chance to familiarise himself with the surroundings They came out on the 12th floor

Going down the corridor, Jonathan knocked on an inconspicious-looking door which had the letter B on it

The door opened Jonathan gently pushed Willy in and closed the door from outside Willy looked expectantly around, but was disappointed

The room was empty

THERE was a table in the room with just one chair facing it Willy was wondering what to do next, when he heard the following words coming from behind the table

"Willy, please take the chair."

Probably a hidden speaker behind the table, so Willy figured as he sat down and awaited further developments

"I apologize that my extreme shyness prevents me from meeting you in person But I can see you perfectly If you want to show me something, please place it on the table," the voice went on in even tones

"Mr B, I want to tell you something that may save Roger Buckland and his team an unnecessary trip and probably their lives " Willy's voice held a note of urgency. But Mr B's voice showed neither surprise nor eagerness·

"Pray continue speaking; I hear you. If you can convince me that you have vital information I may , even at this late hour, stop the space expedition".

"Roger told me all about the invasion by green men He told me that he is leaving tomorrow to find out about them. Who

they are? What distant planet they come from....But he asked me to try to investigate independently He gave me a photograph taken by Dick Frost' Willy continued, but was interrupted

."A grave breach of trust Roger should not have disclosed classified information. Never mind I suppose Roger gave you my telephone number too What have you discovered?"

"I have got this photograph analyzed by an expert And, maybe, I found something that your experts missed," Willy placed the picture on the table and narrated how the analysis of the picture was conducted Then he concluded "That one of the inhabitants of this mysterious spaceship was seen eating a typical item of American junk food, clearly establishes that the invaders are from our own planet, most likely from our own country They are probably kidnapping our scientists and technicians with an evidently foul motive So my advice is don't send another team of scientists tomorrow Rather you should send an armed contingent to overpower these miscreants"

There was a long pause as Mr B was digesting all this Then he responded·

"Congratulations, Willy! You have solved a great mystery Of course I must stop Roger's mission But I wish to give you the credit Please wait outside for a while I will make arrangements to send you to Florida You should go and explain to Roger all your findings"

For the first time he had left Roger's apartment, Willy breathed a sigh of relief

MR B replaced the receiver of his black telephone. This was the phone he used to communicate with his assistants and he had just informed Jonathan what to do next He then lifted the green phone on his desk He had one more phone, red in colour

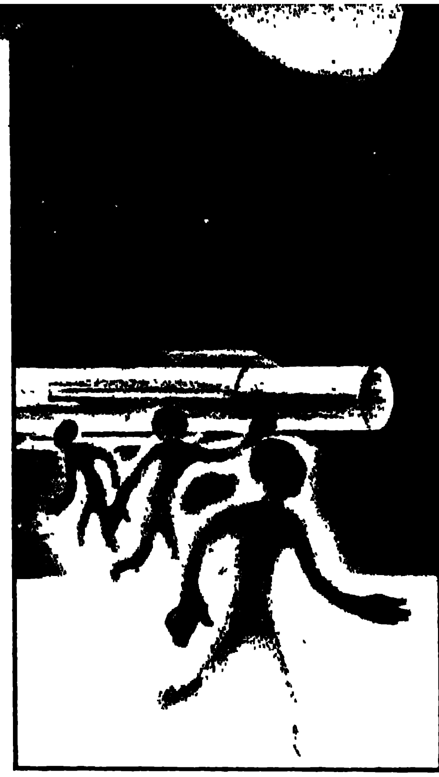
"Mr A?" He asked deferentially

"Hi, B How are things? Is everything ready?"

"Yes, it was all set, but we now have a problem! I have just had a visit from Willy Bones, an F B I agent He has found out that the green men are from our country"

There was an expletive from the other end But A knew how to control himself He asked for the details of what Willy had told B. When he had the whole story, he commented·

"That must be Mike! He is a glutton where junk food is concerned Last month I saw him eating hamburgers and I lost count He kept saying that one more would do him no



harm... Looks like he has eaten one too many"

There was a pause Then B replied with regret in his voice "What should we do now? Looks like our plan for worldwide surveillance has come to nothing! And that too at a time when it was beginning to work as well" After the kidnapping of Roger and his team there would have been consider able scare about extraterrestrials, with Senator Blackman raising hell This was anticipated and an enquiry was already planned And at that enquiry eminent scientists would have testified that there are no extraterrestrials All though this controversy the green men would have continued their spy missions unchecked It was such a marvellous plan...all gone because Mike must have his hamburger!"

"B, you are talking as if the plan was a thing of the past! No It is still very much on" A replied coolly

"How can we continue with it if Willy goes on talking about it? He is now on his way to Florida." B was no longer his calm self

"Excellent This is what I would have recommended myself! We will send him also along with Roger to their secret colony Let him carry on all his investiga ting there"

B saw the point Add Willy to the colony of kidnapped scientists and technicians and no one would be the wiser But here the occasional qualm he used to feel came back to bother him. He voiced it to A,"How proper is it for a nation that prides on freedom of the individual, human rights and so on,to kidnap its own citizens and isolate them?"

But A had answers for all these doubts. He spoke gently "A nation cannot be accused of kidnapping and that too its own citizens Besides, all the scientists and technicians we have isolated are having a comfortable life and they are having job satisfaction working on problems of national security And, after the ten year period, when our project is over, they will be returned."

B felt satisfied After all this was the only way to complete the project which involved the best brains of the country. It would be carried out in secrecy without raising suspicion outside And he knew that scientists "kidnapped" to the colony were working happily after a suitable orientation. Even Frost had taken to his new work enthusiastically

As if echoing his thoughts, A continued, "Recall that at the Manhattan Project eminent scientists worked with dedication to produce the deadliest weapon of the time, because they were convinced that they were working for national security.. Scientists will work with dedication provided they are convinced of the merits of the project We have convinced our scientists and technicians that in this space age, the conquest of space around the Earth is going to be more crucial than the sovereignty of land on the Earth. So they are happily working on our ground project"

"Well," sighed B to himself. "It had to be that way, it had to be that way" He had once been a scientist himself and it saddened him to see scientists being made pawns in a political game There was nothing he could do to prevent it! After all it had happened before

Coming back to practical details, he remarked,"O K We have to sort our one formality, though!"

"Which is that?" asked A

"Willy does not work in my organization. I need authorization from the highest authority to allow him to be kidnapped"

"I will arrange that Good bye," A remarked in a matter of fact way

As B replaced his green receiver he mentally bid goodbye to Willy also. Knowing A's quickness of work he expected action soon He was not disappointed

The red telephone on his desk began to ring □

Prof Narlikar, who heads the Theoretical Physics Group of the Tata Institute of Fundamental Research, Bombay, is also a well known Sci fi writer

POPULATION BOMB:

With its continuously growing human population is the world heading to a Malthusian nightmare? Some experts warn that our planet has already turned into an over-crowded antheap. Others say that population growth, which is one of the factors in a complex matrix, cannot be studied in isolation. And according to some others, "people" are the planet's greatest asset. Are the fears of "Eco-doomsters" ill-founded? Or are the cornucopians deluding themselves? On the occasion of the 150th death anniversary of Thomas Malthus, the renowned demographist and the original prophet of doom, we present the controversy

N August 1984, over 3,000 delegates from 150 countries participating in the UN sponsored International Conference On Populations brooded over the grim prospect of rising population and the attendant problems in the shadow of the Malthusian spectre which seems to haunt them even as the 20th century draws to a close Though the tone of the "Mexico Declaration", which called for effective implementation of the plan to improve the standard of living and quality of life for all peoples of this planet, was rather apocalyptic, it was clear that to the political and practical implications of this declaration were far more serious The Declaration also called for a speedy implementation of the Bucharest programmes (from the World Population Plan of Action after the 1974 conference) Throughout the deliberations, the emphasis was on the developing countries and their urgency to implement population programmes

The concern over the relationship between population and economic development dates back to a couple of centuries to Malthus and Ricardo, both of whom emphasised the relationship in terms of the population pressure on finite land and food supplies Both the Malthusian and Ricardian models with their subsequent variants attribute a central role to "scarcity of resources" and the Law of Decreasing Returns, ignoring the role of technological progress Perhaps at the time when they were writing, England having just embarked on Industrial Revolution, was yet in the nascent stage of technology The rising population pressure on fixed land, if allowed unchecked, would spell the operation of positive and preventive checks Implicit in this dark prognostication were assumptions of constant returns to scale, absence of technology and almost no recognition of the institutional factors—that is, changing attitudes or customs and their positive impact on checking population John Stuart Mill systematised, clarified, elaborated, and quali-

MYTH OR REALITY?

S. R. Kasbekar

fied the ideas of Malthus and Ricardo. He extended the scope of natural resource scarcity and effect to living space and the quality of life. The brief historical sketch drawn here is necessary to understand the current apprehension regarding rising populations and their impact on the quality of [illegible] Since basics of both the problems are the same though their dimensions and degrees have changed

High fertility and baby boom

The Conference on Population held at Bucharest in 1974 had voiced a concern at the high fertility rates being the principal cause of rising population. The global population was projected to rise from the current 4 7 billion to more than 6 0 billion by the end of this century

Historical analysis

A comparative historical analysis is interesting In the year 1 A D, the world had about 300 million people It took more than 1,500 years to double the population The period was marked by fluctuations in birth rates (fertility) and death rates (mortality) Between 1750 and untill well into the 20th century, the world's population grew at about 0.5 per cent a year By 1900, it had reached the 1 7 billion marke; thus doubling in about 150 years Till 1950, the world population grew at one per cent and thereafter at about two per cent per year In just over thirty years between 1950, and today, world population nearly doubled again—growing from 2 5 billion to almost 4 8 billion (see page 2, World Development Report 1984, (OUP)

The most alarming implication emerging from these figures is that a population growing one per cent annually will not even triple in a century, but one growing three per cent annually will increase 19-fold (see page 21 *State of the World*, 1984, Lester R Brown)

The world demographic structure reveals same interesting propositions Roughly after World War I, mortality began to decline in the developing countries Population growth rates varied between two per cent to three per cent a year. Among the countries that have contributed to the world population growth are India China, Brazil, Bangladesh, Nigeria, Pakistan, Indonesia, Soviet Union, Mexico and the United States

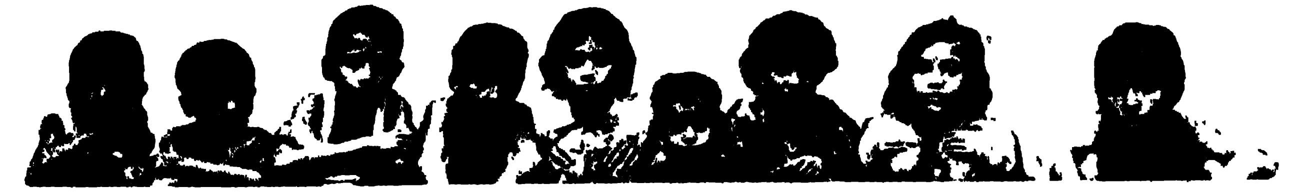
Implications

A fast growing population by itself may not be a burden Whether a rapidly growing population is an obstacle in the growth path of an economy or an asset depends on a number of factors like the structure of population (dependency ratios), availability of capital and technology, level of savings and investment, social framework, institutional and attitudinal factors and the political aspects For instance, in the earlier stages of industrialisation in England in the 19th century a growing population provided an expanding market by stimulating demand, encouraging innovation and reducing investment risks like it does in the US, Europe and Japan today But, for most developing countries today mainly dependent upon agriculture for livelihood for most of their population and a slow industrialising process, a rapidly growing population can mean lower standard of living for most through a disturbed population resource relationship

Thus, the Neo-Malthusians contend the Malthusian relationship between population and land (food supplies) to the availability of energy and minerals The Club of Rome Study (1972) in the early seventies predicted that the pace of technological change would not be sufficient to halt the diminishing returns and that "Doomsday" was inevitable This view is criticised more or less on the same basis as are Neo Malthusians The Club of Rome study does not give adequate attention to the role of substitutes (for instance aluminium replacing steel, plastics among intermediate raw materials, or substitutes in the energy sector), the operation of the Law of Increasing Returns in many fields and the strong faith in the human population bringing about adjustments in resources either through innovations and explorations or through market mechanism by way of rising prices of scarce resources. Julian Simon in his two books, *The Ultimate Resource* and jointly with the Late Herman Kahn *The Resourceful Earth*, pins his hope on the "people, the ultimate resource" trying to dispel the fears expressed in the works of "eco-doomsters" such as the votaries of the Club of Rome study *The Limits to Growth* (1972) *The Global 2000 Report (1980)* emphasise finiteness and exhaustion of resources and spell out the so-called Spaceship Earth Syndrome and ultimate doom.

On the contrary, Julian Simon and others treat "population as a resource" For instance, Dr Naohiro Ogawa of the Population Research Institute at Nihon University, employing computer models, argues that unless Japan increases its population its annual growth rate may decline to one or even to zero per cent, as the labour participation declines over the years As early as 1962, Harold J. Barnett and Chandler Morse, argued in their book *Scarcity and Growth* that the Malthusian hypothesis was applicable only to a very few societies where extremely rudimentary techniques of production existed and social progress was nil Thus they argued, the more complex the society, and the greater its contact with the world, the more impossible it is to define a Malthusian limit which has any operational meaning or significance for policy" The Malthusian scarcity hypothesis, therefore, has rather specialised and limited relevance, and so is not generally useful" (p 140)

The World Bank study strikes a middle approach between the cornucopians (those who believe in the abundance of resources) and ecodoomsters of the NeoMalthusian variety. Thus, recognising the severe consequences of a rapidly growing population for many developing countries in terms of poverty, inequality, low savings, lack of education and employment opportunities (labout absorption), slow technological change and different natural resources •the World Bank advocates



measures to limit population Especially Africa and Sub-Saharan countries are cited as examples where poor agricultural productivity, lack of technological change and a rigid social structure have combined to make the region one of the most slow-growing in the world The World Bank approach advocates population programmes such as family planning on a wide scale

Bharadwaj Approach

Dr Ranganath Bharadwaj has evolved a new approach which incorporates environment as a dimension into the development. In his latest work *Managing Limits to Growth* prepared for Asian and Pacific Development Centre (APDC), Prof. Bharadwaj views man in the entirety of his life-span, articulates an alternative human resource mobilization development strategy where human resource development gets as much importance as human resources utiliin terms of social (inner limits such as poverty) and physical limits (outer limits i e environment) gives primeval importance to human factor as an objective in any development policy The supplementary as well as complementary nature of the relationship between man, resources and its quality are important in human capital formation For a developing country like India this analysis has profound implications as population as a resource would depend upon the correct attitudes and policy mix

India adopted a population policy as early as 1952 under heavy influence of NeoMalthusians. Since then, or even earlier, grinding poverty was seen as a consequence of rising population, and as such limiting population became an aspect of any economic strategy. Like in many poverty-stricken developing countries, where most families have at least four children, in India, too, measures have concentrated on reducing the number of children per family Advances in medical and biological sciences have ensured a higher life expectancy resulting in the fall of mortality rates This means the shift of policy to limit population has centred on attitude. And it is the force of attitude in many developing countries including India, especially in rural areas, which has operated as a check on any measures to limit children. Children are no longer looked upon as a burden but as a potential source of income.

In India, research has centred on family planning under heavy influence and aid from the West. A few gains registered in economic development are sought to be attributed to the success in family planning. As one critique of population research put it, formulation of policy itself has been subject in the absence of deep thinking on the role of population in the total development process. In fact interest in research in population in India is a post-World War II phenomenon. Since the 1891 census, the first in India, the Malthusian shadow has loomed large over our population policy The concern with high fertility and mortality rates was acute till the 1931 census The General Report of the 1931 census felt that efforts to reduce infantile mortality should be preceded by precautions to reduce the birth rate

Recurrent food shortage, however, was seen as a constraint on population growth but it had a limited role in a tradition-bound society where fecundity is regarded as a divine gift.

The relationship between food supplies and population was enunciated in a nationalist perspective by such eminent economists as Radhakamal Mukherjee Gyanchand, D G Karve and Dr Ghosh. who dismissed the overpopulation bogey as divisionery tactics on the part the British Government to distract the attention of people away from political subjugation. These economists, however, were aware of the gravity of the population problem. For instance, D.G Karve, after analysing the relationship between population and food in India, emphasised the need for widespread social and cultural reform and discounted the feasibility of birth control in the absence of such reform.

The emphasis on institutional aspects (social and cultural reforms) did not, however, form a part of the population policy. Right from 1952 to till the day entire emphasis is on family planning (India has a dubious distinction of being the first country in the world to launch an official population policy directed towards the curtailment of fertility).

The emphasis on institutional aspects (social and cultural reforms) did not, however, from a part of the population policy

Two consequences follow from this approach: first is positive or aspiration induced attitudes towards family planning as in South East Asia is based on the increasingly perceived cost of rearing children It has also been realised that the inter-generational flow of wealth over a lifetime is going to be reversed from the traditional children-to-parents stream to the new parents-to-children stream. Second is negative or gloom-induced family planning It is based on the inter-generational flow of wealth from children to parents with its attendant cost and hazards It is this attitude which regards children as assets that dominates most South Asian countries including India. Only with improvements in socio-economic conditions like nutrition, education, employment etc , can some success be chalked up.

Even as the population problem causes concern at the global level, policy measures encompassing international cooperation growth-oriented socio-economic programmes adherence to rational demographic goals, improvement in the status of women, an accomadative inter-regional plan and a spread of knowledge leading to reduction in the number of human beings are being devised under a lengthening shadow of the Malthusian ghost. The world feels less comfortable in the company of cornucopians whom it suspects and would like to see the end of Malthusian ghost it detests. □

Mr Kasebekar is with the Economic Times Research Bureau.

There is fun in basic sciences

BY any standards, Amar was a bright young student, inquisitive and hard-working He had a wide range of interests and generally did well in anything he set his mind on But by the time he finished school, his interest, prodded by his parents, had turned solely to engineering, and then on it was engineering and nothing else So when, despite scoring 83 per cent at the 12th standard, no engineering college would take him, Amar's world collapsed around him

And so it is with thousands of other bright students, caught in this new phenomenon –the craze for engineering and medicine Never mind the number of other interesting and exciting options open—for instance, in biology, geology, physics or botany The cream is in engineering and medicine, the parents think And thousands of good students are annually set, like blinkered horses, on a mad race to lap up that cream

It is a disturbing trend that over the last few years students have been favouring only engineering and medicine Almost every student among the first 50 in the merit list at the 12th standard, when asked, would say he would go to medicine or engineering. Electronics is the latest addition, and commerce the next choice Nothing else mattered

As a result, the other fields are being neglected. Subjects like chemistry, zoology or botany are just faceless subjects which will only help fetch good marks to enter the medical college Students who score the highest marks deliberately avoid such subjects, prompted, of course, by their parents

If all the bright students went into engineering and medicine, can we afford to ignore other areas? Can we neglect agriculture or even our rich variety of plant life? Should we neglect history or the languages, for that matter? Who will man the administrative service? Imagine what will happen if all these streams are handled only by mediocre students A society needs talents in all fields for a balanced all round growth

A mini bio gas plant can be developed which will consume wastage from our homes But there is a dearth of microbiologists to work on this project Research and development in our country is yet to go is yet to go into the problems of animal diseases In every field, there are challenges but no talent to grapple with the challenges

Parents, of course, do not allow their wards to be exposed to these realities There are many fields where one can have much satisfaction and yet earn well A good mechanic may dirty his hands or an agriculturist may wear soiled clothes on the field but he may be earning as much or even a little more than a doctor or an engineer Why, you may find many doctors or engineers who are unhappy and who earn less than an accountant Parents hide these realities from their children and thrust their own aspirations and frustrations on them

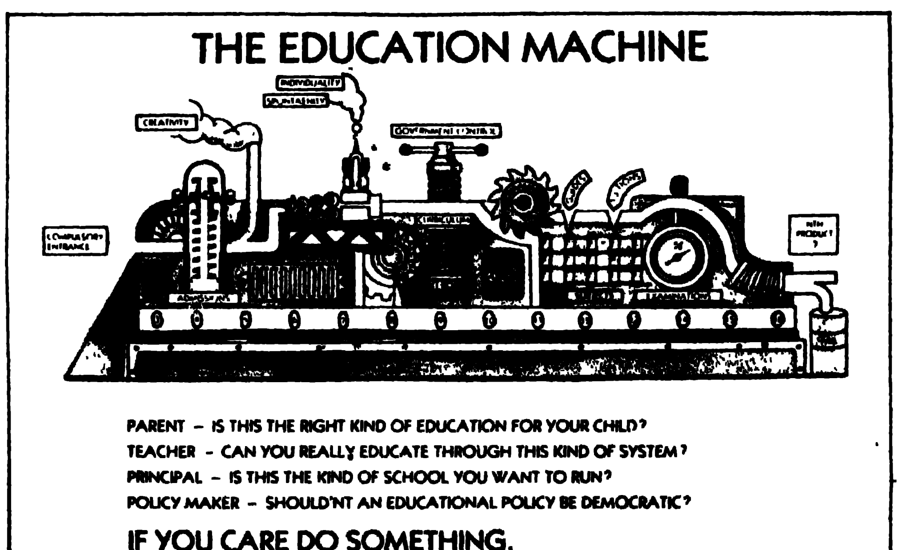
All these distortions in education have caused worries among teachers and public-thinkers So, to create an awareness among students about the necessity and importance of research in fundamental sciences, the Marathi Vidnyan Parishad, an organisation devoted to the propagation of science and the scientific attitude, organised a seminar in September to discuss these issues The results turned out to be very interesting and encouraging

The basic theme of the seminar was excitement in fundamental research Several eminent scientists were invited to speak about the opportunities available in their fields of research to a special audience—students who had scored over 90 per cent marks in the 12th standard examinations. A discussion was to follow The scientists included Dr. Raja Ramanna, Chairman of the Atomic Energy Commission, Prof. Jayant Narlikar, astrophysicist from the Tata Institute of Fundamental Research (TIFR), Prof, B.M. Udgaonkar from the Physics Group of the TIFR, Dr. O. Siddiqi, a molecular biologist (TIFR), Prof. B.V. Sreekantan, a physicist and Director of the TIFR, and Dr. S.P. Sukhatme from the Mechanical Engineering Department of the Indian Institute of Technology

Prof. Siddiqi and Prof. Narlikar were more faithful to the theme. Prof. Siddiqi talked about research in biology. He said that research in this branch of science is not so much expensive, and there are facilities and adequate equipment in India for advanced studies in genetic engineering, single-cell protein production and development of new drugs to fight against diseases like cancer. Students in cities like Bombay and Bangalore are fortunate because there are advanced institutes there. But they are not known to students What is required is the proper dissemination of this information. Because of lack of information, it is possible that students do not go into such research More important, he stressed that there is job satisfaction in fundamental research or even in applied research You learn so many new things when you research that it entertains you as well You remain happy

Prof Sreekantan said that we are today enjoying the fruits of the industrial revolution. From tooth paste to the TV, we use innumerable industrial products. But we tend to forget that it is the work of

An advertisement, a prize-winning campaign on education, created by Shilpi for the Ashok Jain Awards contest for National Awareness Advertising. This campaign won a prize for "A renewed vision provided for an otherwise well-known issue."



The after-twelfth fever

scientists like Newton and Edison that has ultimately resulted in this industrial prosperity. If there was no fundamental research in astrophysics or mathematics or electricity and magnetism, there would have been no developments in telecommunications and space sciences that we see today. And now if we want to take advantage of the space age, we must concentrate on studies in fundamental sciences.

Prof. Narlikar spoke about the excitement in research, and about new developments in the space sciences Though at the moment these developments appear to be of theoretical importance, tomorrow they will bring totally new products For instance, certain new alloys can be produced in space; because of the absence of atmospheric contamination, the process of amalgamation is easier He also said that there is a lot of scope for work in astronomy in India India has hardly 250 astronomers while in the USA the number of recognised astronomers ran into several thousands. A giant 220-cm telescope is ready in Kavaloor, near Bangalore A 4-metre super giant telescope will be ready soon in Uttar Pradesh And the Government proposes to erect an 8-metre telescope in the near future. Who will use them? We do not have enough astronomers We now know the importance of satellite communications If we want to remain abreast with developments in the rest of the world in this field, bright students will have to go to astronomy

Narlikar tells his own story He stood first in the SSC examination. After passing the intermediate examination with flying colours, he preferred science to engineering. Some of his friends who appeared in the merit list also went for fundamental science. Narlikar says that he and others are happy. In the TIFR, he has a cosy life and a lot of leisure, too. He devotes some of his time to writing science fiction. He may not be earning as much as a busy doctor but at the same time he feels that he need not run from one dispensary to other, dawn to dusk, just earning money. He has no tensions

Later in Cambridge, he was excited about working with a renowned scientist like Prof. Fred Hoyle After six months Prof Hoyle asked Narlikar to work with him on a particular project—to substantiate the Steady State Theory of the Universe propounded by Prof. Hoyle This theory had been challenged by Prof Martin Ryle Later, on the day of presenting the work before scientists, Prof Hoyle was engaged in some other work and asked Narlikar to present it before the distinguished audience Those present told Narlikar that he did the job extremely well What an excitment it was! Narlikar feels that this moment had inspired him so much since then Three years later Narlikar had another opportunity of reading a paper, co-authored with Prof. Hoyle, before the Royal Astronomical Society

All the scientists at the seminar pointed out that what matters in research is truth based on facts And a young scientist can question theories of elders based on his research. What matters is not seniority or status but just the strength of one's research and the quality of work.

The seminar did not remain faithful to the basic theme, though. It turned out to be rather some kind of vocational guidance Even so, students were interested, and the question-and-answer session that followed evoked good response, going beyond the time limit for this session

While some wanted to know about the possibility of research on cancer, some said they should know more about research in engineering Others wanted to utilise their long vacations on some project in some laboratory but they did not know where or how A young student said that he observed the sky with his home-made make-shift telescope, he wanted to know more about astronomy. At one point innumerable hands came up showing their approval of participating in study circles in the TIFR Thus out of the free dialogue between the scientists and the students, a possibility of vacation programmes on specific topics emerged

Nilu Damle

Mr Damle is a freelance science writer and participated in the Marathi Vidnyan Parishad seminar

Solar stills for fresh water

S.D. Gomkale

In Narayan Sarovar in the coastal Kutch district in Gujarat, wells have saline water. How to provide drinking water to the village in the faraway arid region? A large solar still was set up recently to convert the saline well water into drinking water and villagers now draw salt-free water from the still. In Bitra, in the Lakshadweep Islands, drinking water to the islanders comes from the sea. A 750-square-metre solar still desalinates sea water.

In regions where fresh water sources are scanty, like in deserts or marshy lands, or where the underground water sources are polluted or saline, to purify and treat the water becomes important. Though a number of desalination processes are available to convert saline water into potable water, for very small requirements, say below 5000 litres per day, in isolated places solar stills are the most attractive method of desalination. This is particularly so for remote regions which lack good quality water and sources of energy and which need very low quantities of water, mainly for cooking and drinking.

Bascially, the solar still is a form of a natural water cycle of evaporation and condensation. Saline water, in a glass or transparent plastic-covered enclosure with a black bottom (to increase the absorption of solar radiation), is heated directly by solar rays and evaporates. The vapour condenses on the underside of the glass or plastic cover and is collected as drinking water through flow channels fixed at the lower edges of the cover which is sloped to facilitate the flow. The glass or plastic cover has a dual function, it helps retain heat inside the still by the "greenhouse effect", letting in shortwave solar radiations and reflecting back longwave heat radiations reradiated from the surface of the still, and its underside acts as a cool surface for the water vapour to condense on. The efficiency of the still depends mainly on the solar radiation falling on the still and the solar energy absorbed by the saline water. The figure here shows the basic design of a solar still. There could, of course, be many variations in design as well as construction. And work on solar stills is being done in several countries.

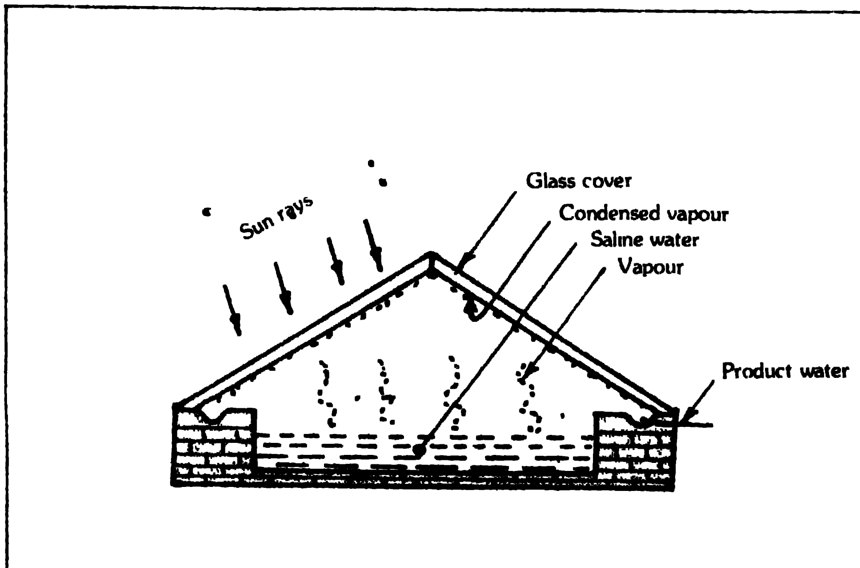
Though solar distillation has been known for a long time (the earliest reference in literature is to the Arab alchemists), a large solar still was first built in Chile in 1874 to supply fresh water to a nitrate-mining community; this was the conventional single basin-type solar still. The still, about 4700 square metres in area, yielded about 5 kg of drinking water per square metre of the still surface. But work on solar stills picked up after the First World War and several types of stills were developed. Some also used metal-coated reflectors to concentrate solar rays while others used devices to track the Sun continuously in a bid to increase efficiency, but such systems had some operational problems. During the Second World War, an air inflated plastic still was developed in the US for use by its Navy and the Air Force. A porous felt pad, saturated with sea water, was suspended in an inflated plastic bag and, on evaporation, the water vapour condensed on the underside of the bag. This was collected in bottles kept at the bottom of the plastic bag

In India, work on the solar still and its modifications has been carried out in many institutions. The Indian Institute of Technology in Delhi has, for instance, developed a double-basin still (see box). This has two glass covers, one above the other, thus providing two basins for water evaporation and a larger capacity for the same land area; the output here is about 36 per cent higher than the single basin still.

At the Central Salt and Marine Chemicals Research Institute (CSMCRI) in Bhavnagar, Gujarat, the effort focuses on the development of large capacity solar stills. The designs have provisions for collecting rain water also The CSMCRI has installed several such large plants at far off places like Narayan Sarovar (2,400 litres per day capacity) in Kutch, the Bitra Island (2,000 litres per day) in Lakshadweep, Awania village (5,000 litres per day) in Bhavnagar, and Bhaleri (8,000 litres per day) in Churu district of Rajasthan. Except for the Bitra plant which uses sea water, other stills use saline well water. However, cyclones and heavy rains have damaged some of the plants, which highlights the need to improve the quality of the stills so that they can withstand such havoc. And

Continued on page 55

Fig. 1 Solar still



Types of stills

T[illegible] is a [illegible] glass cover, [illegible] an inlet for saline water and an outlet for potable water are provided, and except for these, the whole enclosure is air-and water-tight. The sides and the bottom of the enclosure are insulated to minimise heat losses. The still can be kept on the ground (ground still) or mounted on a stand (mounted still).

Let us look at a typical basic configuration of such a still (Fig. 1). A [illegible]-gauge galvanised iron (GI) sheet painted entirely black with blackboard paint forms the basin or the enclosure of the still. The top is covered with a 3-mm thick window glass sloped at 10 degrees. The still is insulated on all the three sides (except the top) with a 10-cm thickness of glass wool. This insulation is covered with blackboard which again is encased in a galvanised iron box. Thus the still has double iron walls on three sides with insulation and blackboard in between. An opening near the bottom drains out unused saline water.

How you place the glass cover on the vertical walls is critical (Figs. 1a, 1b and 1c). The insulation [illegible] covered at the top with [illegible] edges of the glass cover [illegible] between a mild steel (MS) T-[illegible] and a timber beading (1b). [illegible] however, no timber beading [illegible] sloped edge. Here, a V-shaped [illegible]nium gutter is placed to [illegible] condensate to flow (1c). [illegible] gaskets are used at the joints [illegible] the set up air-tight. Fig. 2 [illegible] common designs of single basin [illegible] stills.

The efficiency of the still [illegible]

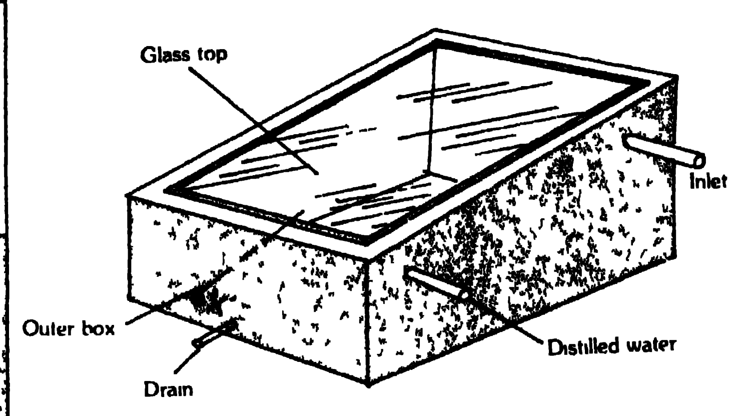
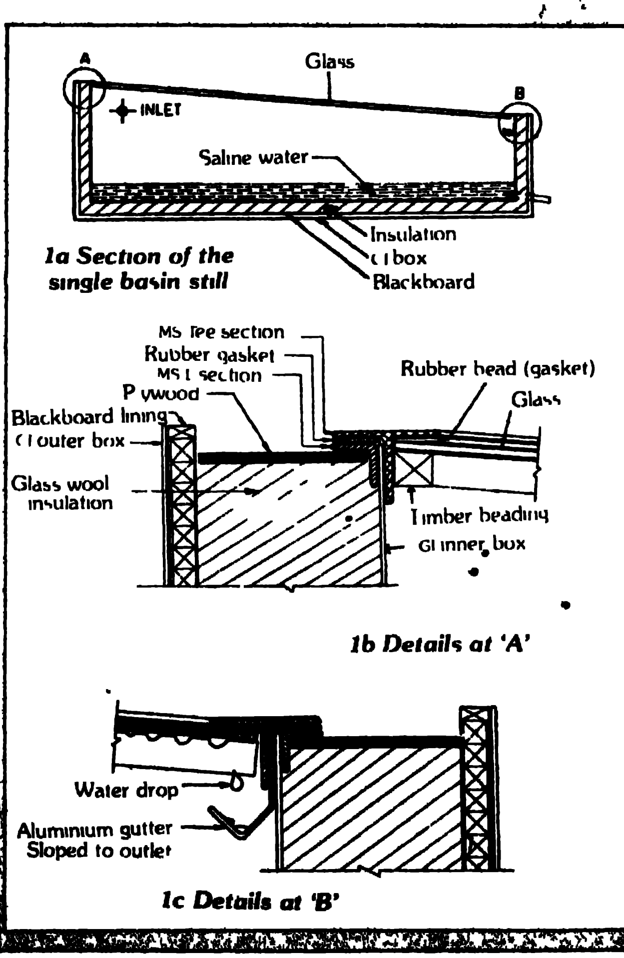


Fig. 1 The basic configuration of a single basin solar still

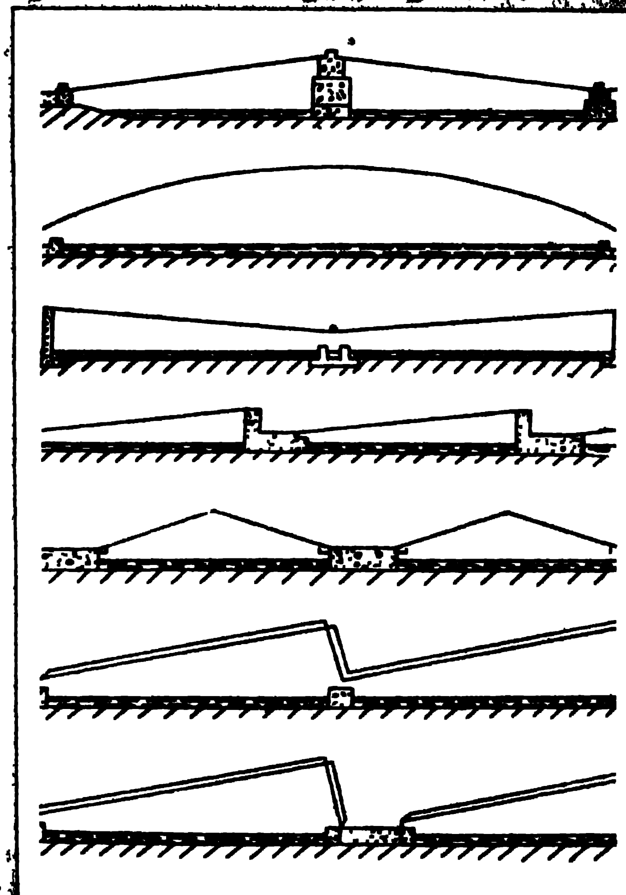


1a Section of the single basin still

1b Details at 'A'

1c Details at 'B'

Fig. 2 Some common designs of single basin solar stills



[illegible] of solar radiation [illegible] still and the amount [illegible] the water. And the [illegible] of solar energy absorbed by the [illegible] and the blackened base [illegible] on the reflectivity of the [illegible] and the water surface, and also [illegible] water film condensed on the cover. The output of the still, however, decreases slowly as the salt concentration in the water in the still increases. Studies have also shown that the output increases when a [illegible] is added to the saline water.

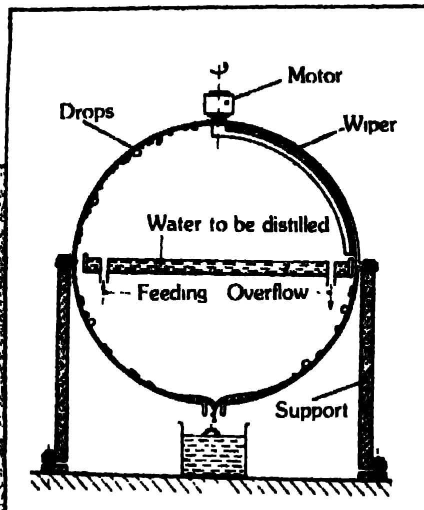


Fig. 3 [illegible]

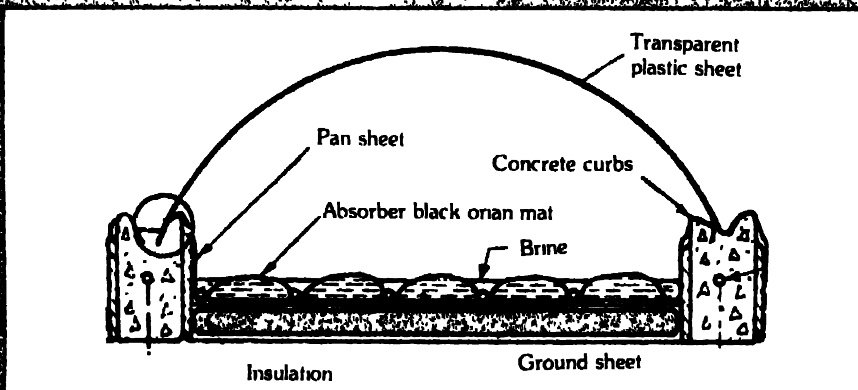


Fig. 4 Air-supported plastic still

Several attempts have been made to improve the efficiency of the still. One [illegible] is to force circulation of [illegible] the still. Other methods [illegible] the use of the latent heat of [illegible] which is otherwise [illegible] in multiple effect systems or for [illegible] the saline water.

Among the various types of solar stills are the wiping spherical still, the concentric tube still, air-supported plastic still, extruded plastic still, double basin still and the still on roof.

The wiping spherical still is a sphere placed on two stands (Fig. 3). The lower half of the sphere, which forms the basin, is blackened metal and the upper half is glass which acts as the cover. Water drops condense on the inside of the glass cover, and a wiper attached to the cover wipes them towards the lower hemisphere through narrow gaps. Wiping increases output by about 25 per cent as the cover remains transparent throughout and it also prevents distilled water droplets from dripping back into the basin.

The concentric [illegible] two concentric tubes [illegible] which [illegible]

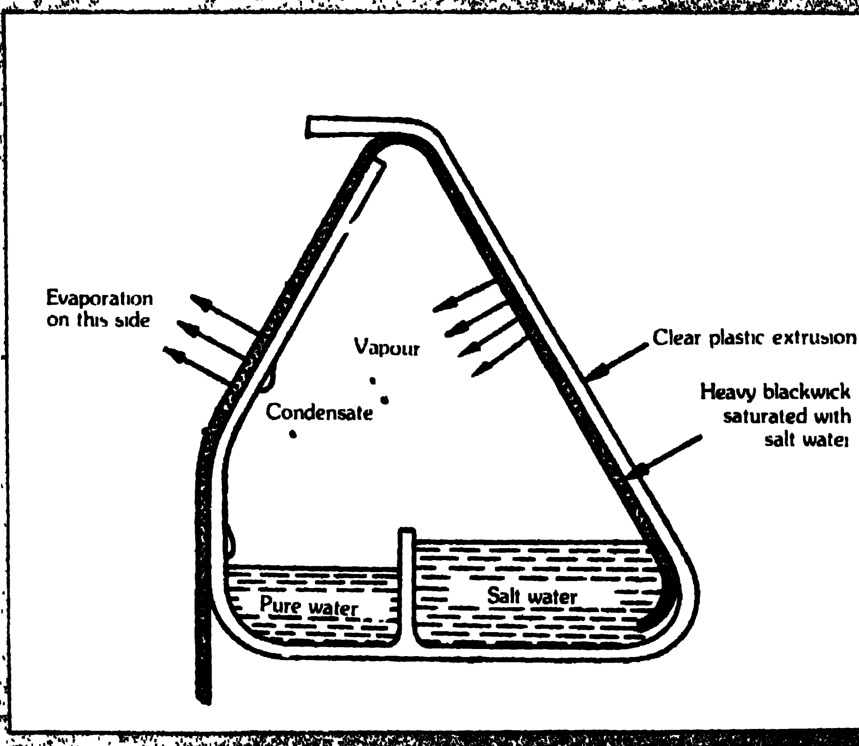


Fig. 5 Extruded [illegible]

[illegible]

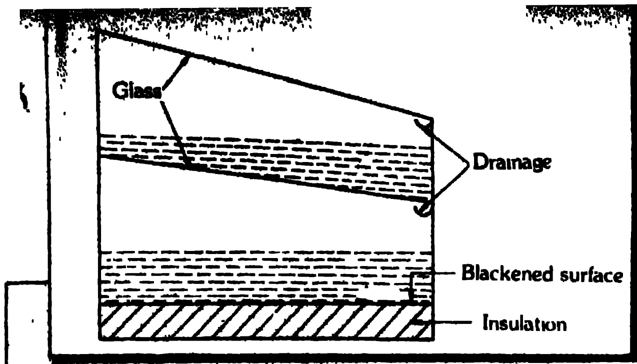


Fig. 6 Double basin still

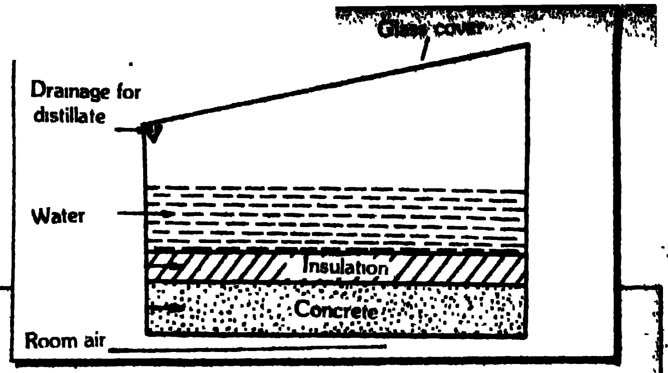


Fig. 7 The "still on roof" system

In the extruded plastic still, a heavy black wick saturated with saline water placed along a side of the inner surface of the still is heated by solar radiation (Fig. 5). The water gets evaporated and condenses on the other side of the enclosure. The water is collected at the bottom.

The double basin solar still makes use of the latent heat of condensation on the underside of the glass cover in a still by placing another glass cover above it to form two basins and, in effect, two stills, placed one above the other (Fig. 6)

Besides obtaining distilled water, solar stills can also be used to control heat in a building by placing a still on the roof. Studies conducted in Delhi showed that on a typical hot day, the heat flux inside the house was reduced by 40 per cent and in a cold day it was nearly doubled.

(From Reviews of Renewable Energy Sources (Vol 1) ed by M.S. Sodha, S.S. Mathur, and M.A.S. Malik)

Continued from page 52

though experience shows that the plants can be operated and maintained in villages without much problem, much depends on the co-operation of the villagers and the person looking after the plant.

The most important factor against the solar still, however, is its high cost. The investment for the CSMCRI design ranges between Rs. 250 and Rs. 300 per square metre of the still surface, and larger stills with capacities about, say 2,500 litres per day, have surface areas over 1000 square metres. The fresh water output being totally dependent on the solar energy input, productivity ranges from two to three litres per day per square metre. Lower output and higher investments per unit area thus raises the total cost, and makes the still uneconomic compared with other alternatives, except, of course, for low water demands in remote and isolated areas as mentioned earlier.

Obviously, it is necessary to find ways to increase output with only a very small increase in investment. There is also a need to develop modular designs, with the modules just assembled at the site where the plant is to be installed. And areas where water scarcity is only occasional and also where the scarcity is linked solely with the monsoon can be served by mobile solar stills—ready to assemble units stored at a central location and installed and operated only during the scarcity period. Development work needs to be pursued along these lines too.

Dr Gomkale is with the Central Salt and Marine Chemicals Research Institute, Bhavnagar

Fig. 2 Solar stills at Narayan Sarovar in Kutch district, Gujarat

Resources for tomorrow

AROUND 1850, hundreds of cities and towns around the world started using gas for street and home lighting This revolution in lighting was made possible by Carl Auer, of Austria who patented a chemically treated gas-mantle in 1885 When the gas was ignited, heat from the flame made the mantle incandescent causing it to glow brilliantly with greenish blue light The invention earned Auer the title of Baron Von Weblash and the gas-mantle became known as Weblash mantle or more commonly incandescent gas-mantle The great era of gas lighting was short-lived in western world and began to dim when Thomas Edison invented electrical bulb However the incandescent gas lights remained in use in many parts of Asia and India till a few decades ago Even today portable kerosene - filled gas lights using Weblash mantles brighten homes in our villages remote from power lines, and marriage functions, shops and fruits stalls in most of our cities.

But now another type of revolution in the field of energy production is in the making. It is expected that by the turn of the century fast breeder nuclear power reactors will be operational providing heat and light to far away villages in India

Contrasting though these two revolutions appear, there is a common thread The element responsible for these two events, separated by over a hundred years is thorium. The incandescent gas-mantle is made up of thorium oxide while the fuel to be used in breeder power reactors will come from metallic thorium. Thorium is thus the energy metal of tomorrow

History and occurrence

The discovery of thorium is attributed to Berzelius who in 1828 reported the separation of new earth from a mineral, now called thorite, found in Norway. The name thorium was derived from Thor, Scandinavian god of war

Thorium is not a very rare element, it comprises 0 001-0.002 per cent of the earth crust and is distributed widely. It is as plentiful as lead and molybdenum and thrice as abundant as uranium. Among the thorium bearing minerals, about 55 have been reported to contain over 1 per cent thorium. The most important source, however, is monazite, a phosphate of rare earths and thorium. Thoriamite, a mixed thorium-uranium oxide, $(Th, U)O_2$ and thorite, the silicate of thorium, $ThSiO_4$, are two other minerals rich in thorium content. But they do not constitute significant industrial sources.

Thorium is a breeder metal

The major commercial source of oxide and metal is monazite, which is essentially a phosphate of thorium and yttrium earths, $(Ce, La, Y, Th) PO_4$. In addition it has small amounts of Fe, Al, Ca, Mg, Ti, Zr. Uranium in trace quantities is also present. Monazite deposits are found in India, Brazil, United States, Australia, Sri Lanka, Africa and Canada. The Indian monazite contains the highest amount of ThO_2 up to 9 9 per cent It is found in plenty on the beach sands along with other important minerals such as ilmenite, zircon, rutile, garnet, sillimanite etc Indian deposits on the beach sands of Kerala, Tamilnadu, Andhra Pradesh, Orissa and inland deposits of West Bengal and Bihar are presently the world's largest Typical analysis of the Indian monazite in comparison with that of Brazil and US is shown in the Table

Recovery from monazite

Monazite sand is the only ore from which thorium is being extracted commercially The major impurities are titanium, iron, silica and phosphate. The first step in thorium extraction is to break down monazite and separate thorium, uranium and rare-earths from the gangue material This is done by chemically opening the ore and fractionally precipitating either the valuable elements or gangue The thorium is then separated from uranium and rare-earths. The thorium concentrates thus obtained are then purified before being reduced to metal. There are, in general, two chemical processes commonly used for opening thorium ores.

The acid process: In most commercial processes in the United States, the ground monazite is treated with hot

THORIUM

sulphuric acid which dissolves the thorium, uranium and rare earths. The residue consists of undigested monazite, silica, zircon and other gangue material. The sulphate solution carries along with the valuable elements the phosphate ion. The clear acid solution is carefully neutralised with alkali to precipitate selectively all of thorium while uranium, rare-earths and phospate ion remain in solution. The separation method is mainly based on exploiting the difference in the uranium complexes at various acidities. As mentioned above, 98-99 per cent of thorium in the acid solution is recovered by diluting it with 6-7 parts of water and neutralising the resultant solution with ammonium hydroxide to pH 1.05. The filtrate from the above is further neutralised to pH 2.3 to recover rare-earths and some uranium. Uranium is finally precipitated at pH 6.0. Further purification of thorium is done either by solvent extraction or selective precipitation.

Caustic extraction process

The alkali process, investigated and developed in France, USA and Russia has been adopted in India and Brazil. In this method the finely ground monazite is treated with hot concentrated caustic soda solution, when gangue goes into solution leaving behind the valuable elements which are recovered as hydrous oxides. The removal of phosphate from the other metals not only facilitates the subsequent purification but also gives a valuable by-product, sodium phosphate. Another advantage of this process is that the recovery of uranium is higher compared to that from the acid process.

The slurry is obtained after the alkali digestion is filtered at about 100°C and washed until virtually all soluble elements are removed. The cake containing hydrous oxides of Th, and rare-earths is dissolved in acid and when separated by selective precipitation. Thorium is further purified by solvent extraction.

Purification of concentrates

For applications in nuclear reactor technology thorium must be freed from elements which have a high tendency of absorbing thermal neutron. It has been calculated that as small an amount as 1 ppm of gadolinium in thorium causes a loss of 0.8 per cent in production of U^{233}. Uranium, which is invariably associated with thorium in small amounts has to be removed since its presence would cause dilution of fissile U^{233}.

Three major methods of purifying thorium concentrates are possible, solvent extraction, fractional crystallization and selective precipitation. Among these, for large-scale production of high purity thorium metal, the solvent extraction process is more desirable. This was quickly achieved

Fast Breeder Test Reactor, Kalpakkam

since a similar method for processing uranium had already been developed. Considerable similarity in certain chemical properties between thorium and uranium also helped The commercial grade (mantle grade) thorium nitrate forms the feed stock for this process. A large number of solvents have been tried but the one most widely used is tributyl phosphate diluted with kerosene

For purifying the crude thorium cake obtained from Indian monazite, a modified process of precipitating the thorium as oxalate, converting it to nitrate and subsequently extracting it with tributyl phosphate is followed

Metal production

Throrium has a high melting point (1690 ±10°C) and is very reactive especially at elevated temperatures. It gets contaminated by contact with air and by reaction with most container materials. Processes for thorium production, however, have been developed which circumvent problems poised by these peculiar characteristics

Commercial method yielding relatively high purity-metal include reduction of the oxide with calcium, reduction of ThF_4 with calcium and a trace of zinc chloride or fused salt electrolysis of halides The product obtained by oxide reduction and electrolysis is in powder form which is then converted to solid massive metal by powder metallurgy techniques Great care has to be exercised in handling powdered thorium since it can be pyrophoric.

In the oxide reduction method the charge consisting of thorium oxide, calcium metal and calcium chloride is heated under an inert atmosphere of argon gas to about 1200°C. The final mass is crushed and treated with water in tumbling barrel, care being taken to maintain the temperature below 40°C in order to guard against the oxidation of the metal powder The powder is next treated with 15 per cent nitric acid to remove any residual calcium, and its salts and any oxide film that may have formed. It is finally washed with water and vacuum dried This method yields about 99 6 per cent pure metal

The commercial-scale production of thorium metal sponge is done by the reduction of thorium tetrafluoride (ThF_4) with calcium and zinc chloride

The charge is placed in a sealed bomb lined with fused dolomite The reactor is placed in furnace at 700°C Enough heat is produced to yield a molten thorium-zinc alloy and a fluid slag which on cooling separates cleanly from the metal ingot Zinc is distilled off the alloy by heating it at 1000°C under vacuum Thorium obtained in the form of sponge is melted and cast into solid metallic billet

The fused salt electrolysis of the double fluoride of thorium and potassium ($KThF_5$) in a melt containing potassium and sodium chloride is carried out at an optimum temperature of 800°C The graphite container serves as the anode while molybdenum is used as cathode. The cathode deposits are leached free of the adhering salts, vacuum dried and the powder obtained is consolidated by powder metallurgy methods into ductile thorium. The electrolysis recovery of thorium is independent of the supply of calcium. This coupled with the fact that electrolytical process is amenable to continuous or semi-continous operation, make this route especially attractive.

To make small amounts of ultrapure thorium metal, the Van Arkel-de Boer process has been used. Lower purity thorium metal and a small amount of iodine are placed in a moderately heated evacuated vessel The thorium iodide vapours formed in the vessel pass to a very hot surface (tungsten filament) where they decompose and deposit the thorium metal. The iodine vapours re-cycle to the lower purity thorium and react forming fresh metal iodide and the cycle continues.

Properties and compounds

Massive thorium is silver-white when fresh, but turns dark grey when exposed to air. It is stable at room temperature, and is not effected by water even at 100°C, however, finely divided thorium is pyrophoric. It dissolves rapidly in aqua regia and in concentrated hydrochloric acid. It is unaffected by aqueous solution of alkalies

Thorium metal is characterised by a relatively high melting point, low hardness and high ductility at room temperature It can be cold or hot formed in many operations. However, the cold workability of thorium is greatly reduced by impurities. In hot working operations, such as extrusion and forging, thorium may be heated without special protection up to about 800°C

In its chemical behaviour thorium is a reactive metal with electropositive character similar to that of magnesium. It forms only one series of salts namely, those of tetravalent thorium ion. It has the least tendency to hydrolyse of all the known positive ions. Thorium ion has a strong

Composition of Monazite sands
(wt per cent)

[illegible]	India	Brazil	U.S.
[illegible]	9.9	[illegible]	3.4
[illegible]	27.5	25.9	19.5
[illegible]	29.5	25.5	20.5
[illegible]	1.5	2.51	8.5
[illegible]	0.4	[illegible]	2.1
[illegible]	—	—	[illegible]
[illegible]	59.8	60.5	[illegible]
[illegible]	0.27	[illegible]	[illegible]
[illegible]	0.01	[illegible]	[illegible]

Table 1

tendency to form negative complexes with excess of such ions as CO_3^{-2}, $C_2O_4^{-2}$, SO_4^{-2}, and PO_4^{-3} in acid or neutral solutions. Its ion forms double salts such as $K ThF_6, 4H_2O$, $NaTh_2(PO_4)_3$, $MnTh(SO_4)_3, 7H_2O$ etc etc.

The massive metal or sponge reacts with hydrogen at 300-400°C to form thorium hydride. The direct reaction of hydride with halogens eg., Cl_2 or Br_2 at 250-350°C give corresponding halides. The hydride also reacts with hydrogen compounds such as steam, hydrogen halides, hydrogen sulphide, amonia, phosphine to give binary thorium compounds. Methane or carbon dioxide do not react with the hydride.

Applications

The major impetus to the renewed and enhanced interest in thorium is due to its potential uses in the atomic power programme. Nonetheless, its use in mantle for portable gas lights still represents a sizable fraction of the total consumption.

The mantle grade thorium nitrate contains about 0.5-1.0 per cent added sulphate to improve the mechanical property of the refractory oxide. Addition of about one per cent cerium also improves the spectral emmissivity. The gas mantles are made by impregnating cotton or synthetic fibres with 25-50 per cent solution of the nitrate containing 1-2 per cent cerium nitrate. The mantles are then denitrated by converting the thorium nitrate to thorium hydroxide by washing with dilute ammonium hydroxide. When initially burnt, a skeleton of ThO_2 remains which gives off brilliant bluish white light when heated with gas.

Low tensile strength, elastic modulus and poor resistance to corrosion remove this metal from the list of structural engineering materials. However, recent applications of its alloys show good promise. Magnesium thorium alloys which contain about 3 per cent thorium and 0.1 to 1.0 per cent zirconium have very high mechanical strength at elevated temperatures, thus finding applications in aviation and rocketry where mechanical strength combined with low weight is important. Another application of thorium for imparting superior mechanical strength and corrosion resistance to a metal is so called TDNi which has nickel containing about 2 per cent dispersed thorium oxide. It has excellent corrosion resistance at elevated temperatures.

The uses of thorium oxide are basically dependent on the high melting point and stability coupled with a low dissociation pressure. It is responsible for controlling the grain size of tungsten filaments used as a source of radiant energy. Such thoriated tungsten filaments have hot vibrational strength probably due to increased strength at the grain boundaries. They are also used in electronic tubes for thermionic emissions.

The Indian scene

The thorium fuel cycle is of great significance to India which has the largest and richest known reserve of this material occurring in the beach sands of Kerala, Tamilnadu, Andhra Pradesh and Orissa. It is well known that thorium, though not fissionable, is converted into a fissionable isotope of uranium, U^{233}, by neutron irradiation. The fissiles U^{233}, on account of its chemical dissimilarity with thorium, can subsequently be separated from the irradiated thorium by chemical processing.

The nuclear power generating programme in India, as formulated by the late Dr Homi Bhabha, envisages a three stage development. In the first stage, the present generation of nuclear reactors based on natural uranium will provide power and plutonium as a by product.

The second stage reactors will use plutonium thorium as fuel, thus producing power and yielding fissionable U^{233} as a by product. These reactors are termed as "converters". In the third stage, U^{233}-thorium fueled reactors will provide power and produce or 'breed' more U^{233} than they will consume. Hence the name breeder reactors.

Since the early days the beach sands from the west coast of India have been processed to extract ilmenite and monazite. As the demand for rare earths and thorium grew the extraction of these components became economically attractive.

However, a planned effort started when in 1952 Indian Rare Earths Ltd., a Government of India Undertaking, set up a plant with the help of Societe des Produit Chimiques des Terres Rares of France at Alwaye in Kerala to treat about 4.5 thousands tons of monazite annually. The products of this plant are rare earths chloride and thorium concentrate. Tri sodium phosphate is obtained as a useful by product.

The production of thorium metal from nuclear grade thorium oxide by calcium reduction has been carried out at Bhabha Atomic Research Centre.

Dr Ahuja joined Bhabha Atomic Research Centre after completing his doctorate at the University of Florida and post doctoral work at the Universite de Montreal. His research interests include development of high purity materials for use in electronic industry organic and organo metallic compounds.

WHY **POLYMERS**

any of us may not know that polymers make or mar our day. The tooth brush or the news paper we start the day with, the bread and butter we breakfast on, the plastic bucket and mug we use for bathing, the cotton, silk or synthetic garments we clothe ourselves in and lastly the bed, of foam or cotton, we retire into are all nothing but polymers in various forms. What is more, many fluids and all proteins found in our body too belong to the large family of polymers.

Polymers derive their name from the Greek words *polus* (many) and *meros* (parts or segments). As the name implies, they are made of long chain-like molecules consisting of a great many small parts. These small parts may be of one kind or different, repeated in a regular fashion. A simple polymer, polyethylene, is a linear chain, built from the same chemical unit—CH_2—repeated as many as a million times. Myoglobin, a protein molecule, is, however, much more complex; its long chain is folded into a compact form (Fig. 1).

Many fascinating properties of polymers can be explained (only qualitatively in many cases) in terms of the structure and mutual interactions of their long and flexible chain molecules. To start with, let us look closely at the polymer which makes *pooran poli* possible. The fine outer jacket in which this delicacy sits is made of starch, a naturally occurring polymer. Each granule of starch is a bundle of numerous starch molecules, which do not dissolve in water. The mixture of starch and water, used as a dough, has to be soft and pliable, for rolling into thin layers. That is the reason the dough receives a harsh treatment in the form of pounding and kneading. In the process, the molecular chains break loose and get dispersed evenly in the water medium. As the chains uncoil and stretch out, water gets into the pores making the dough swell.

This dough, though supple, is not viscous enough to flow. A synthetic polymer made of silicone oil too has the same consistency but behaves very differently. Roll out an egg of this material and leave it to rest, it slowly flattens itself out, flowing like a liquid. Throw the egg on the floor, it bounces back as if it were made of rubber. There are many such materials, which, when forced to respond quickly, recoil as if they are elastic. Given more time they flow like a viscous liquid. This viscoelastic property comes from the knotting of the numerous polymer chains present in these materials. These entangled chains may be compared to a heap of snakes or earthworms, creeping, wiggling and sliding over one another. When slowly deformed the chains can slide through but they have difficulty in adapting to sudden changes, hence they recoil.

Elastic recoil could be seen in many polymer solutions. I could observe it in a viscous paste of starch (*maida* in water) meant for starching garments. When this fluid is stirred gently with a spoon, after removing the spoon, the fluid moves first in one direction and then, slightly, in the opposite direction. The elasticity of the fluid is due to the coiled chains which behave as springs. Another curious property of the same fluid can also be verified easily. The viscosity (resistance to flow) of the fluid changes markedly when it

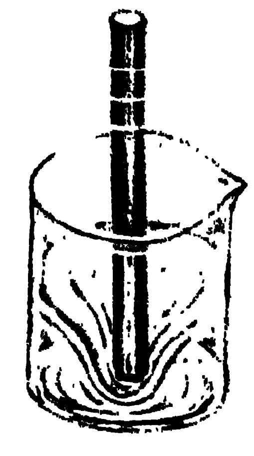


Fig. 2a A rotating rod in a normal liquid

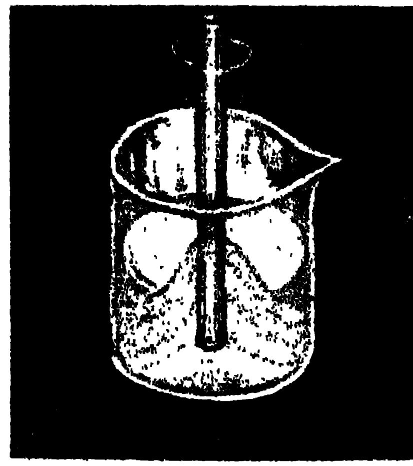


Fig. 2b The rod in a solution containing long polymer chains

Fig. 2c Disc rotating in a normal liquid

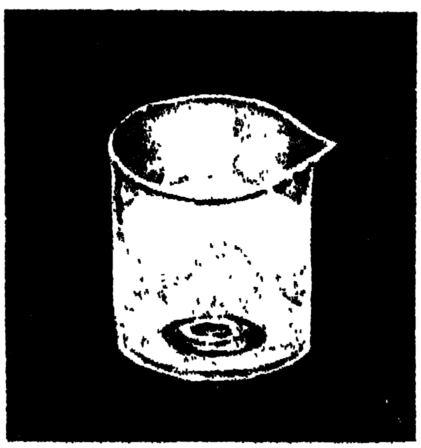


Fig. 2d Disc rotating in a polymer solution.

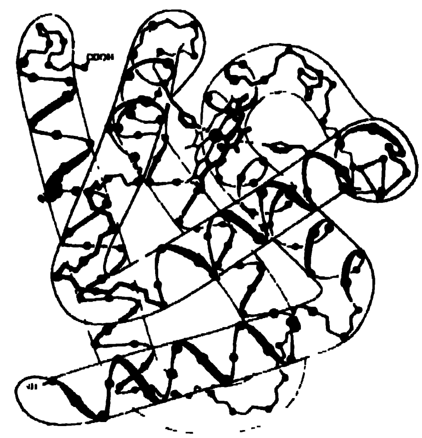


Fig. 1 Myoglobin molecule

BEHAVE STRANGELY

is vigorously stirred. Stirring, pouring and spreading are different ways of shearing a liquid and this fluid is shear-thickening If you whisk it briskly with a rod, it thickens, and sticks to the rod The fluid column looks like stretched chewing gum Lift the rod gently, the fluid runs down easily With a thicker paste, the rod cannot even enter the fluid readily if it is pushed in suddenly whereas if slowly inserted there is not much resistance at all The ink used for ball-pens has exactly the opposite tendency —it thins under pressure flowing more easily

Some polymer solutions are found to behave very differently from normal liquids such as water, under certain conditions of flow A look at the pictures alongside will make this clear (Figs 2) Near the rotating rod or disc, the water surface goes down but the polymer solution is doing the exact opposite, it is climbing the rod! Why is it being forced towards the centre? This

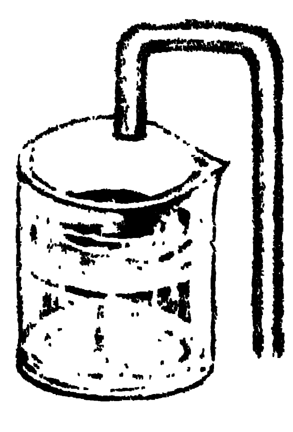


Fig. 2g Syphoning with a normal liquid

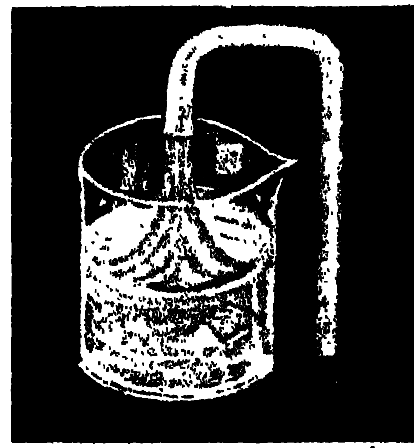


Fig. 2h Self-syphoning of a polymer solution

Fig. 2e A normal liquid thins out

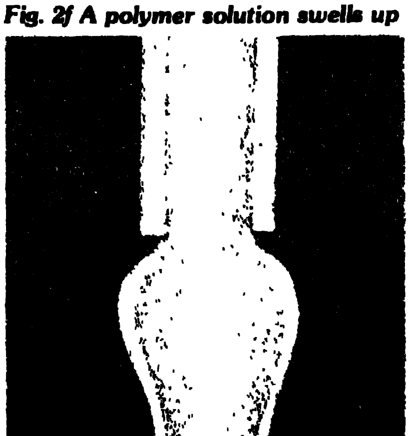
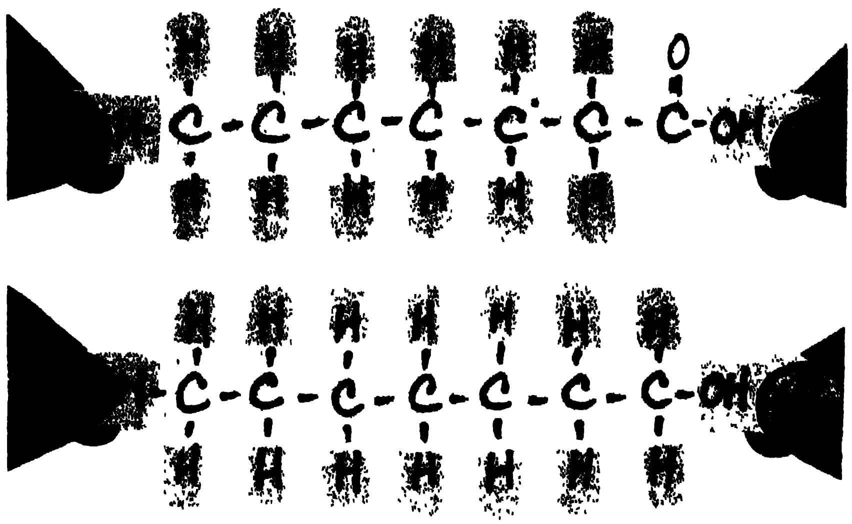


Fig. 2f A polymer solution swells up



radial force results from the movement of the liquid in concentric rings Since different rings move with different velocities they rub against each other producing a shearing force, due to the complex structure of the polymer chains, in the radial direction, which tends to pile up the liquid at the centre The swelling of the solution when it is forced through the tube is, probably, due to the recoil effect The increase in size could be as many as five times, which is a nuisance in the manufacture of synthetic fibres (polymer solution drawn into fine threads) The self syphoning effect is, perhaps, the most fascinating of all Even with a gap of several centimetres above the liquid surface, the polymer solution can be syphoned out! A single strand sticking out of the tube is probably pulling another one and so on until the container is fully emptied -the tangled tale of polymer chains?

Polymers present in minute amounts are found to change the behaviour of a normal liquid markedly It is found that small amounts of (01 per cent) poly ethylene oxide can stabilise the water jet used in fire-fighting by preventing the jet from breaking down Some aquatic animals like dolphins are known to exude polymeric solutions to reduce the hydrodynamic drag These and many other bizarre properties of polymeric solutions are yet to be understood, as it is relatively a new field

Indira Murthy

Dr Murthy is on the editorial staff of Science Today

TATA INSTITUTE OF FUNDAMENTAL RESEARCH, BOMBAY

VISITING STUDENT RESEARCH PROGRAMME, 1985

leading to

SELECTION OF Ph.D. RESEARCH SCHOLARS, 1986

TATA INSTITUTE OF FUNDAMENTAL RESEARCH, BOMBAY

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Applications are invited from outstanding research-motivated students who are in the first year of Master's degree course, for the Visiting Student Research Programme of the School of Physics of the Institute.

The objectives of this programme are twofold:

1) to provide young scholars an opportunity to interact actively with research programmes at TIFR and thus strengthen their motivation for a research career

and

2) to preselect research scholars for the Ph.D. programme at TIFR, commencing in the summer of 1986.

Students chosen under this scheme will have the opportunity to spend about six weeks sometime during May to July 1985 working with a research-group in TIFR. Their programme will include guided advanced studies, specific assignments/projects as well as lectures and seminars. This programme is open only to the first year M.Sc. students of Physics, Chemistry or Applied Mathematics, and M. E./M. Tech. students specializing in Computer Science who will have completed only the first year of their Master's degree course by summer of 1985 It is also open to students entering their final year B. Tech. in Computer Science. Participants will be interviewed at the end of the programme and those selected in the interview will be made an advance offer of a position as research scholar at TIFR for the Ph D. programme starting in August 1986, subject to their satisfactory performance in their final M Sc/M.E./M Tech./B.Tech. examination. The monthly honorarium for research scholars at TIFR is Rs 1000/- in the beginning which is normally raised to Rs. 1250/- per month once the initial training period is over. Moreover, those with outstanding performance are absorbed into regular academic positions at TIFR after their Ph. D. or earlier

Research activities in the School of Physics at TIFR include.

EXPERIMENTAL NUCLEAR SCIENCE	- Nuclear interactions; high energy particle physics; heavy ions, nuclear reactions and spectroscopic studies, etc.
EXPERIMENTAL SPACE SCIENCES	Cosmic rays; gravitation; radio, X-ray, optical, infrared and gamma ray astronomy
EXPERIMENTAL ATOMIC AND SOLID STATE PHYSICS	- Magnetism; superconductivity; semiconductors; device physics, atomic and ionic collisions, etc.
THEORETICAL STUDIES	Elementary particles and fields, nuclear theory; solid-state theory and statistical mechanics; astrophysics; cosmology, etc
CHEMICAL PHYSICS	-- Bio-inorganic chemistry; energy-transfer; fast reactions; molecular bio-physics, laser spectroscopy etc
COMPUTER SCIENCES	- Speech and digital systems; theory of programming; distributed programming; experimental programming etc.

The Institute has modern and well-equipped laboratories pertaining to the above areas. Major facilities include (1) the deepest underground laboratory in the world at Kolar Gold Fields for cosmic ray and neutrino experiments and the study of proton decay, (2) a radio telescope at Ootacamund, (3) a nuclear accelerator (14UD pelletron) which is expected to become operational by the end of 1985, (4) Nd YAG/dye lasers and FT-NMR spectrometer for solid-state and chemical physics experiments, (5) balloon facilities at Hyderabad for cosmic rays and space sciences, (6) possibilities of rocket-and satellite-borne experiments and (7) CYBER 730 and VAX 11 780 computers

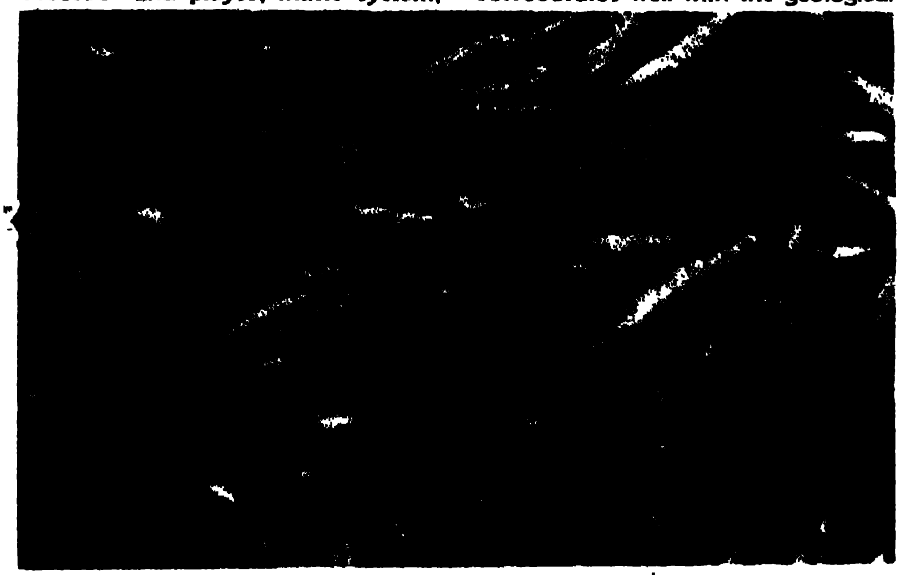
To apply for participation in this programme, send request for application form to the Administrative Officer (Establishment), Tata Institute of Fundamental Research, Homi Bhabha Road, Bombay-400 005, along with a self-addressed, stamped (90 p) 9" x 4" size envelope not later than January 15, 1985. The last date for receiving the filled application forms is January 31, 1985.

Those students, who are chosen for participation in this visiting programme, will be paid return second-class train-fare from their home towns as well as a stipend of Rs. 500/- per month. Arrangements will be made for hostel accommodation during the programme.

It is a tremendous achievement for India to be the first among the developing countries to have set up a permanent station in Antarctica

continued from page 20

points of the building. All waste water and fluids are discharged at a suitable depth through drains. The drains trace is heated electrically and insulated to avoid freezing. Solid waste is converted to fluid through disposomatic machines. Fresh air from outside the building is sucked in through a duct and let out at appropriate places only. The living accommodation is quite comfortable. The kitchen is equipped with modern gadgets. There are a video cassette recorder and player, music system, table tennis equipment, a small library, indoor games etc for entertainment. This station, having modern facilities for scientific observations and research, now functions as an excellent laboratory and a cosy home for the 'winter party'



Krill in Antarctica

Scientific work

During the first two expeditions studies in the fields of meteorology, oceanography, geology, geophysics and other branches of science were initiated. In addition to setting up of the permanent station, the third expedition pursued these studies. These are given in a nutshell here

The scientific work was carried out on the voyage to and from Antarctica, at the sites of mooring the ship, at the base station and at the Schirmacher Hill region. Meteorological parameters were monitored throughout. The permanent station has a well equipped meteorological laboratory.

The entire 35 sq km area of the Schirmacher Hill region, where rocks are exposed, was mapped on a 1: 25,000 scale Geological work indicates possible mineralization. The total intensity magnetic surveys conducted in the zones of mineralization corroborates well with the geological evidences.

Studies have been carried out for pH, dissolved oxygen, alkalinity, salinity and chemical constituents on water samples collected from the Antarctic Seas from depths of upto 2000 metres. Chemical analysis is being carried out on soil and snow-ice samples as well.

The Antarctic Seas are rich in zooplanktons, particularly krill. Systematic sampling has been carried out to estimate krill biomass values Productive lake sites and soil samples analysed for microbial flora indicated the presence of rich microbial populations. A well equipped biological laboratory has been set up at the base station for further work.

An amateur radio was successfully operated throughout the expedition and some 1,400 contacts were made all over the world. The satellite communication through the Inmarsat System makes our permanent station well connected on a global basis. A study of the ionospheric layer is extremely important for radio communication and has been continued from the first expedition. This time, a riometer tuned to 20 MHz was used. Additionally, a microbarograph was used to measure surface wind fluctuations These experiments are being continued during the winter at the base station.

The scientific work conducted during the third expedition has opened up bright possibilities for further exploration of this fascinating continent, mysteries of which are being gradually unravelled

Back home

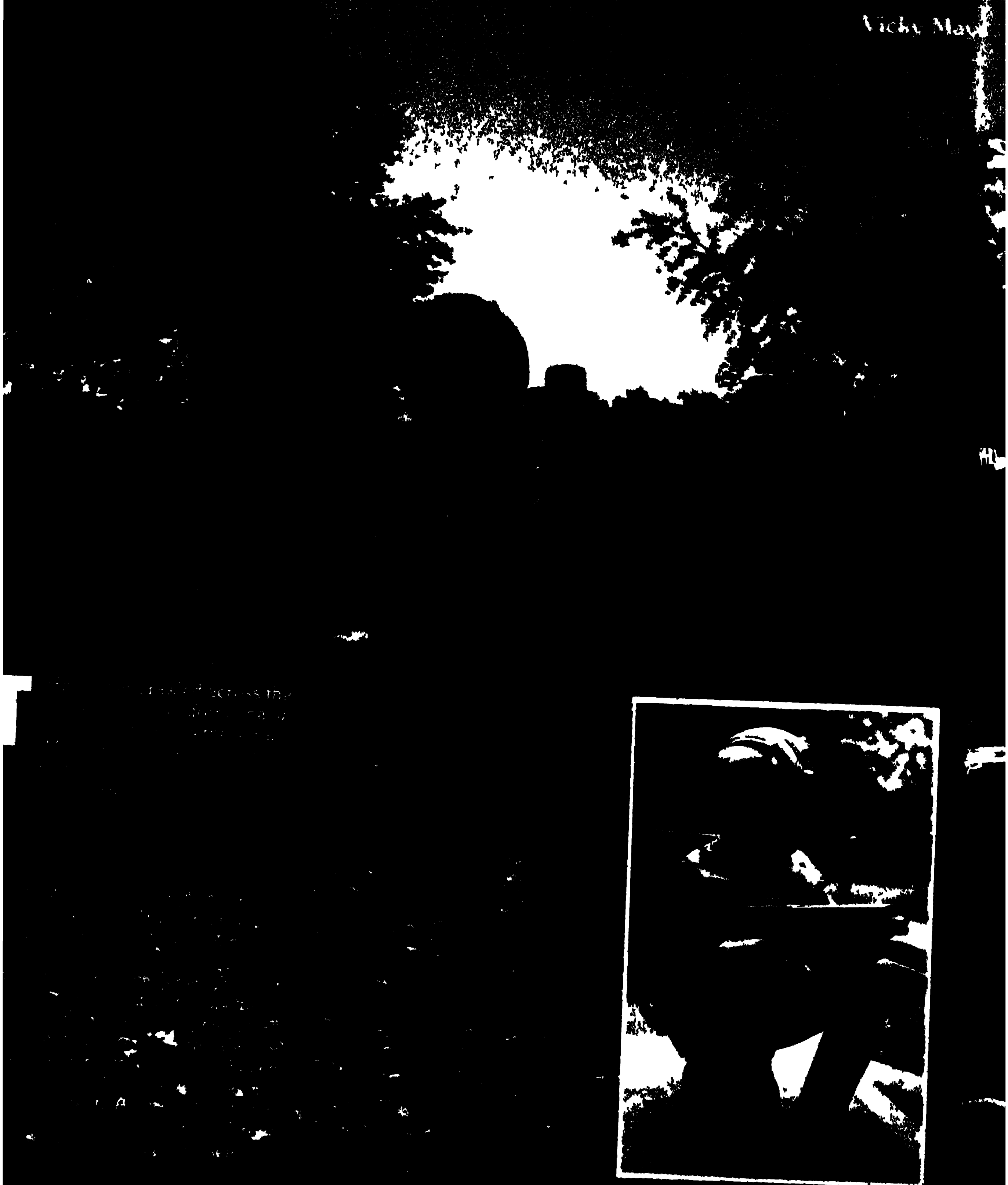
Leaving the 'winter party' behind, the third expedition left Antarctica on 1 March, 1984 and reached Goa on 29 March By now the 'winter party' had already completed a full Antarctic winter stay. The permanent station has functioned well and efficiently and has withstood the onslaught of severe blizzards and extremely low temperatures. The team continues the scientific work braving against sweeping blizzards and permfrost Antarctic climate.

It is a tremendous achievement for India to be the first among the developing countries to have set up a permanent station in Antarctica It is all the more commendable that this major task was achieved during one Antarctic summer, incurring minimum expenditure, compared to any other countries involved in Antarctic exploration Having set up a permanent station at Antarctica, India is now on a par with developed countries in creating research facilities on this most fascinating frozen continent. □

Dr Gupta, Director, Centre for Earth Science Studies, Trivandrum was the leader of the third Indian scientific expedition to Antarctica. He is a recipient of the Bhatnagar Award

TOMORROW'S WARFARE

Vicki May



A hand-held imager

War is no longer a matter of physical strength—the battle is in the laboratories where sophisticated weapons and defence systems are created. And at the British Army Equipment Exhibition, 1984, in Aldershot, Hampshire the wraps were taken off the latest designs

The "chameleon" battle suit, which will become the new uniform for infantrymen, changes colour to blend with the background—the perfect camouflage. And the reinforced helmet, which looks like a prop from a fantasy film, is one of the most researched and advanced pieces of uniform. Apart from its extra protection it has maps and target instruction displayed on the visor. And that lightweight, double-barrelled gun is aimed with the help of a sophisticated laser.

The introduction of the new hand-held thermal imagers, TI, has almost robbed the retreating soldier of the protection of a smoke-screen The device has a heat sensitive telescope which detects objects through heat and smoke-screens It will almost certainly be used by armies around the world But other services—police, coastguards and firemen—could well find it invaluable in searching for lost victims in bad weather conditions or smoke-filled rooms Even so, the soldier could still escape unnoticed according to the Chemical Defence Establishment at Porton, Wiltshire For a new smoke-screen has been developed to counter the progress in thermal imagers.The system, called VIRSS, visual and infra-red screening smoke, is an entirely new idea Another ingredient has been added to the current smoke-screen to prevent most thermal imagers "seeing" through It creates infra-red energy in bursts of air, forcing a dense smoke-screen to appear in just two seconds. This is backed by a regenerating smoke-barrier 60-metres thick and seven metres high. So the soldier and his tanks would have a better chance of escaping his enemy without being spotted.

Even the tanks, which were first introduced in 1916, have a new look They are more comfortable and fitted with the latest safety gadgets And they are designed to conquer varied weather conditions and land challenges

The Saxon combat vehicle, is not simply designed to attack It has a steel armoured hull which will withstand very heavy fire. And the underside of the vehicle is "V"-shaped. This gives a greater protection against unexpected land-mines, petrol and nail bombs While the soldier in the MVC-80, an armed personnel carrier, could certainly destroy another vehicle as far away as the horizon Made of reinforced aluminuim, rather than steel, it carries a powerful gun, a 30mm Rarden canon, in a two-man turret

But the manufacturers have come up with a device that could counter even this – the deadly anti-tank weapon, the Lawmine Unmanned, and set up alone in a firing range it will automatically engage a target at any distance between 10 metres to more than 100 metres As soon as a vehicle crosses its path it is sensed, and a round fired to hit the target at its most sensitive point The weapon is the result of many years of research in a joint project between British Aerospace and Hunting Engineering Ltd

At the same time, the soldier lying deep in his trench can protect himself from aircraft attack using the Rapier system. This air defence system fires missiles at high speed against low-flying attacking aircraft But until recently they have not been very manoeuvrable Now, with the new Tracked Rapier, it can be easily moved from one part of the battlefield to another. The latest improvement allows it to fire eight rounds of missiles simultaneously within seconds of being triggered. It also has an armoured and air-conditioned cab for a three-man crew.

And in the heat of the moment there are charcoal masks to protect the fighter's face They give temporary protection from surprise attacks of chemical vapours and nerve gas

But should he not escape the battlefield without injury, help is closed at hand for the soldier. Emergency transportable buildings are being introduced Designed by a Southampton firm, operating theatres can now be moved very close to the scene of the fray Traditional battlefield units are usually not strong enough for use as operating theatres But with these units, fully-equipped hospital theatres can be quickly transported to the disaster area by land, sea or air and be operational within minutes of arrival

A devious bomb disposal vehicle could also help make the war zone safer The Ro-Veh is a remote-controlled unit, which can be easily carried in the back of a car It is fitted with two detectors that differentiate between explosives and false alarms

But for the soldier who has everything there is the 22-carat gold-plated Sterling sub machine gun At a cost of £3,000 it is twelve times more expensive than the normal army issue But it fires just as accurately Worth its weight in gold, it is the ultimate in gilt-edged investments

•

(Asia Features)

In India we have several plant species which produce oilseeds

VEGETABLE BUTTER

ooking oil adulterated"—screamed a newspaper headline, followed soon by several more in the same vein Consumers throughout the country were enraged when they read about the adulteration of vegetable fats with animal tallow And this adulteration was true for nearly all brands of hydrogenated vegetable fats Many recapitulated the horrendous days of 1857 when under the British rule, cartridges were greased with animal fat

The above issue, sure enough, soon died down but many consumers were left absolutely baffled about what to use as an alternative considering their religious sentiments Little did they realise that chemically there is not much difference between the fats obtained from animal and plant sources Several plants yield valuable fats/oil which is nutritionally and taste wise superior to oils obtained from animal sources This oil from plants closely resembles hydrogenated fats, *desi ghee* or butter

Chemically, fats are glyceride esters of fatty acids which are monocarboxylic acids containing a carboxylic (acid) group (COOH) The unsaturated acids have atoms linked by double or multiple bonds These fatty acids when solid are known as fats and when liquid, they are called oils

Hydrogenation of fats is a complex process which consists of converting unsaturated fatty acids into saturated ones The oil in liquid phase is simply converted into a solid fat by the action of gaseous hydrogen in the presence of a solid catalyst like nickel Even copper can be used as a catalyst for this reaction The double bonds in the unsaturated fatty acid structure is of the *cis* form which after hydrogenation achieves a *trans* form This process brings about a dramatic change in the melting point of the original oil Margarine is also a similar product used as a substituent for butter

Among the oilseed-bearing plants there are several growing in different parts of the world apart from those indigenous to our country, whose seeds furnish butter or ghee-like fat resembling hydrogenated vegetable oil The fat assumes the texture of butter or ghee when it contains 60 per cent or more of the saturated fatty acids For quick absorption of the fat in the human body the melting point of such fats should range between 31 and 7°C

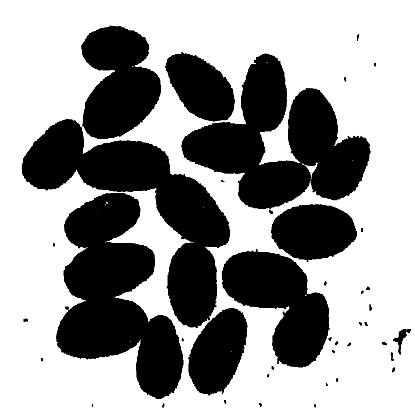
Let us now unearth the hidden treasures of nature which are full of plant seeds yielding useful oil In India we have several plant species which produce oilseeds to form different types of fats (butters)

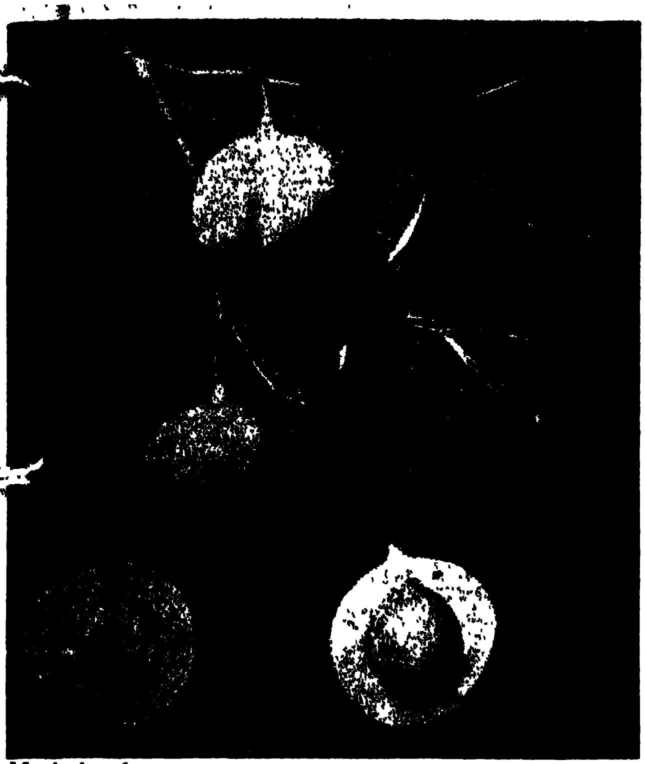
Edible butters

Many trees yield fats which are used in cooking, confectionary, chocolates, etc Cocoa butter is obtained from cocoa tree *Theobroma cacao* These trees are cultivated in tropical places and a normal tree bears at least 70 to 80 pods in a year

***Madhuca latifolia* (left) and *Madhuca butyracea* (right)**

Cocoa beans





Myristica fragrans

Rhus succedanea

The cocoa beans give cocoa butter which has a pleasant aroma, taste and is long lasting. Coatings of chocolates, candies and bonbons are made out of this butter. Another type is the *kokum* butter (Goa butter) obtained from the seeds of *Garcinia indica* which grows in the tropical rain forests of the Western Ghats. The trees are also grown over a large area in Goa. There are other species of the same genus which also produce similar fats which are used in cooking and confectionary. Mango butter from the seed kernel of mango, *Mangifera indica*, is used widely in chocolate manufacture. The whole of coastal region in India is full of coconut trees. The fresh kernel is consumed all over India and its fat forms an ingredient of many Indian food preparations.

The others which have similar edible uses are Indian kapok oil from small browth seed of silk cotton tree, Chinese tallow from *Sapium sebiferum*, introduced at various altitudes in Northern India, and Java almond fat obtained from trees cultivated in Kerala.

The butter obtained from Chura tree known as Phulwara butter is a white fat with pleasant flavour having a texture like "Dalda." It is locally called as chura ghee and is a popular cooking medium.

Industrial and medicinal butters

A well accepted industrial commodity is the Mowrah butter obtained from Mahua trees found in central and east India. The fat from the seeds of several species of *Cinnamomum* yield Kusu fat. These seeds contain a high amount of lauric acid, a fatty acid which is a good raw material for the manufacture of synthetic detergents. Although, Pisa and Litsea fat also have been found to be good sources of lauric acid, they have not attained practical importance. Nutmeg tree cultivated in Tamil Nadu, Kerala and Assam yield nutmeg butter. Commercial nutmeg butter, an aromatic fat, is obtained from undersized, damaged or worm eaten kernels which are unfit for sale as spice. The fat is used as a mild external stimulant in ointments. The fats from other species are used as an embrocation (lotion) in rheumatism, sores and pains.

The fatty acid composition of all fats vary(Table). For proper assimilation we require fats melting below 37°C. In several instances the melting point ranges from 33° to 54°C. By blending solid and liquid fats, ghee, butter or tallow, the desired quality of fat can be produced.

There is an ample oppurtunity and big scope in the country to exploit such oilseeds at the time when there is a big demand for fat, for edible and industrial purposes. The trees which yield butter or ghee products can be planted on a massive scale and exploited judiciously. This will certainly help reduce the gap between supply and demand of fat and reduce our oil import. India has the benefit of a varied climate, from the Alpine type in Tamil Nadu, Kerala and the arid type in Rajasthan to the highly humid type in Assam and West Bengal. This gives rise to a rich and varied flora, often quite distinctive.

Some fats from different plant species grown in India

Common name of fats	Plant source	Fat yield (per cent)
Cocoa butter	*Theobroma cacao*	50-55
Kokum butter	*Garcinia indica*	48
Mango butter	*Mangifera indica*	6-12
Indian kapok oil	*Bombax malabaricum*	18 26
Chinese tallow	*Sapium sebiferum*	55 78
Java almond fat	*Canarium commune*	68
Phulwara butter	*Madhuca butyracea*	60 65
Mowrah butter	*Madhuca latifolia*	50 60
Kusu fat	*Cinnamomum camphore*	42
Pisa fat	*Actinodaphne kookerii*	48
Litsea fat	*Litsea glutinosa*	35
Nutmeg butter	*Myristica fragrans*	38 43

R. Banerji **Gopal Misra**
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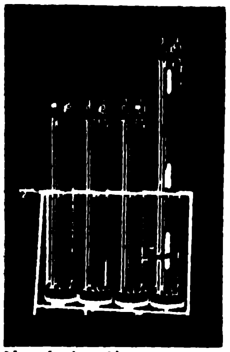

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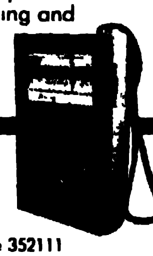

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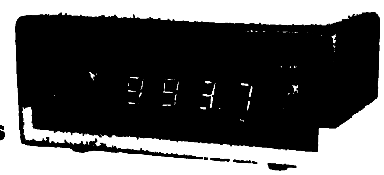

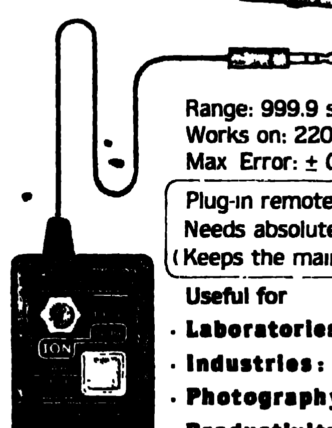

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Continued from page 24

ctic mountains running between them and forming the third tectonic province. East Antarctica, facing the Atlantic and Indian Ocean, forms a Precambrian shield—a large segment of the continent that lost its internal mobility and was stabilised long ago. In the Palaeozoic era it suffered minor vertical movements, causing certain parts—the stable platforms—to be submerged by the sea. The flat Palaeozoic sedimentary beds now occur over an old basement of metamorphic and igneous rocks

West Antarctica is the smaller part of the polar continent and lies off the Pacific side of the south sea. It is believed that if the present ice sheet were to disappear, the area would probably become an archipelago of several islands West Antarctica is composed of younger rocks of Mesozoic and Tertiary age This area has suffered widespread tectonic and volcanic activity and is structurally and morphologically related to the South American Andes through the Scotia arc

The Transantarctic mountains lie between the Precambrian shield of East Antarctica and the younger folded belt of West Antarctica. This mountain chain nearly coincides with an ancient geosynclinal belt in which several sequences of sedimentary rocks were deformed during different episodes of mountain-building since early Palaeozoic times. These strongly deformed rocks are overlain by the flat-lying Beacon group of rocks consisting of tillites, coal beds and rocks containing fossils of the *Glossopteris* flora—a group of ancient plants typical of the southern supercontinent Gondwanaland. These rocks are very similar to those found in the Gondwana sequence of India, Australia, Africa and South America

Our present area of investigation is located in the Queen Maud Land of East Antarctica. The basement complex of East Antarctica consists mainly of unfossiliferous high grade gneisses and crystalline schists of Precambrian age with granitic intrusion of different episodes. These rocks are mainly

Floating mountains of ice, with sea ice in the foreground

exposed along a broad mountain range with a general elevation of more than 1000 metres and running parallel to the present coast line at a distance of 200 km from the ice shelf The Schirmacher range, our area of study, is a 20 km long and approximately two km wide isolated ridge that lies midway between the main mountain range and the ice shelf

The average elevation of the range is 100 metres from the ice shelf with a number of peaks higher than 200 metres There are twelve glacial lakes, the largest having an area of one sq. km. South of the range lies a sheet glacier with a prominent tongue protruding through the hill range

The entire range shows prominent glacial erosion and weathering with U shaped valleys and extensive occurrence of moraines at considerable elevations and with a glacial polish on the rock exposures. Wind erosion is dominant at higher altitudes where the rocks have a pitted surface and are honeycombed and friable

The rock types found are high grade gneisses of different varieties with intercalated metabasites The lithology includes augen gneiss, garnet-biotite gneiss, banded gneiss, migmatites, mylonites and amphibolites The intrusives include lamprophyres and dolerites. Disseminated occurrences of sulphides of base metals and graphite were also found in this range The rocks of this area suffered multiphase deformations so typical of the Precambrian gneisses in other parts of the world

The whole range of 35 Sq km area was mapped geologically and structurally and samples were collected for detailed analyses of petrological, mineralogical and geochronological studies. Such studies will bring out much more interesting information and will enable us to compare similar rock types in India

The last days

As time passed the Antarctic summer became austral autumn The Sun started to set below the horizon, and the mercury in the thermometer was gradually moving downwards, blizzards were more frequent and sunny days more rare At last, the time to leave the icy continent arrived--the time to leave behind a part of our team to man the newly built permanent research station *Dakshin Gangotri* They will be there to witness the long polar night and bring back a bagful of information and many new experiences While we bade them farewell so many of us silently bade Antarctica au revoir. □

Dr Sengupta is a geologist at the Department of Geological Sciences, Jadavpur University Calcutta She was a member of the third Indian expedition to Antarctica

The Answers

(Continued from page 33)

1. Adiabatic:-B In thermodynamics, an adiabatic process is a change occurring within a system without transfer of heat energy to or from the system. A rapid periodic expansion and contraction of a gas is very nearly adiabatic Any process that occurs within a container that is a good insulator is also adiabatic Adiabatic processes are characterised by an increase in entropy or degree of disorder, if they are irreversible and by no change in entropy if they are reversible Adiabatic processes cannot decrease entropy

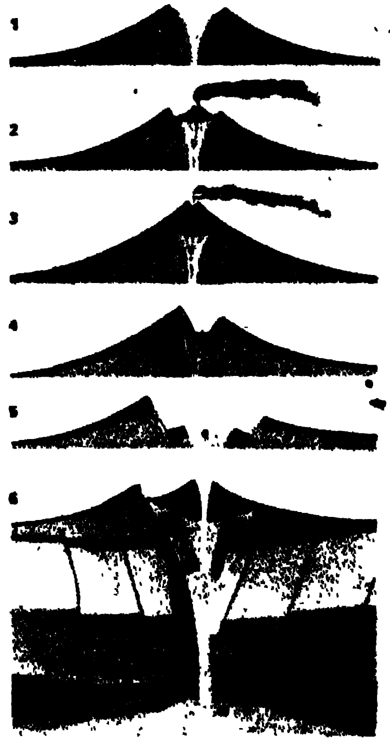
2. Photosynthetic:-B Photosynthesis in green plants is the conversion, in the presence of light, of water, carbon dioxide and minerals into oxygen and various organic compounds

Literally, photosynthesis means "putting together with light energy" Without photosynthesis, the Earth's atmosphere would be devoid of oxygen. If plant photosynthesis were to stop, most living things would disappear from the Earth in a few years

3. Synaptic:-A: Pertaining to the synapse or neuronal junction, it is the functional connection between two nerve cells (neurons). It allows nerve impulses to be transmitted from one cell to the next. The synapse with its chemical transmitter substance, acts as a physiological valve, directing the conduction of nerve impulses in regular circuits, preventing random or chaotic stimulation of nerves and wasting of energy.

4. Magmatic:-C. Magma, the word from which 'magmatic' is derived, denotes molten or melted rock It contains gases that are mixed or dissolved in it Lava is magma that has reached the surface of the Earth but has lost most of its dissolved gases Magma contains crystals of minerals in some form Magma is thought to originate from the thick, normally solid layer between the crust and the central core It comes up from deep cracks in the earth, between areas of rock that have shifted It accumulates just below the surface and feeds the vents of volcanoes

There are different types of volcanic eruptions so the manner in which magma is extruded from the earth's crust varies The figures alongside show the mechanism by which magma feeds the vents of an active volcano



5. Chemotactic:-A: Chemotaxis represents the movement of an organism in response to a chemical concentration gradient and an orientation response of an organism to a chemical stimulus An example of a chemotactic response includes the migration of white blood cells to the site of injury or inflammation when there is a wound or infection in the body The exact mechanism by which this occurs is the subject of much controversy

The winners!

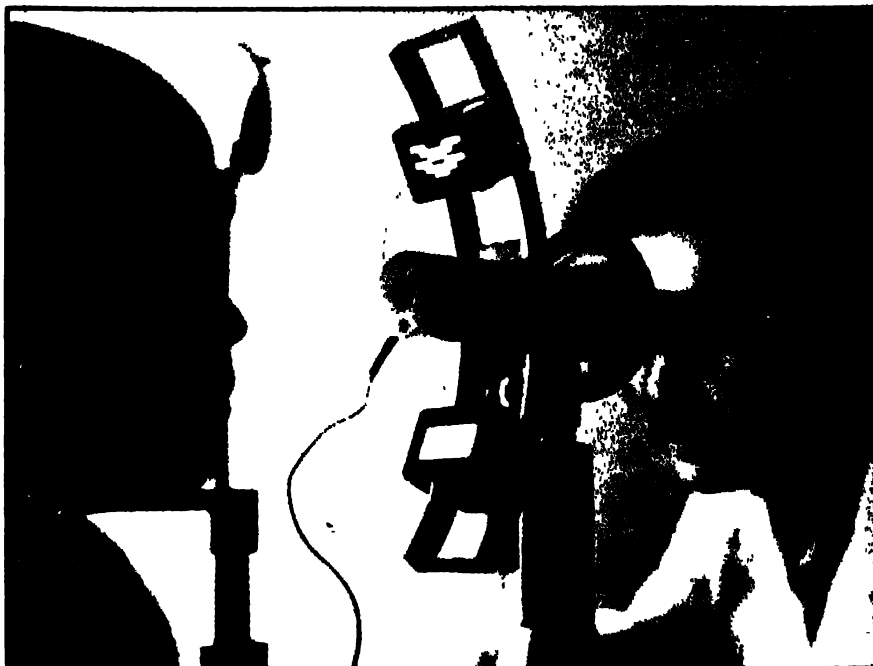
THIS month we announce the winners of both the July and August competitions They are M.C Anbudorai of Pondicherry and Jyoti M. Parekh of Baroda respectively.

6. Pneumatic:-A: The adjective 'pneumatic' pertains to systems operated by air or any other gas. Pneumatic devices generate and use compressed air in a wide variety of applications. These include automobile tyres, pneumatic construction tools like rock drills, pavement breakers and rivettes, machine tools for metal processing such as forging presses and grinders, air cushions to absorb shocks, paint sprayers, blast cleaners, atomizers and conveyers

Compressed air power is flexible, economic and safe An air-device creates no spark hazard in an explosive atmosphere and can be used under wet conditions without any electric shock hazard For these reasons, compressed-air power is the only type of power used in mining and construction operations

7. Aliphatic:-C: Aliphatic compounds have been described in two ways. The first definition describes aliphatic compounds as "those organic compounds of hydrogen and carbon, characterised by a straight chain of carbon atoms" The second description classes "any chemical compound belonging to the organic class in which the atoms are not linked together to form a ring" as an aliphatic compound. One of the major structural groups of organic molecules, the aliphatic compounds include the alkanes, alkenes and alkynes and substituents derived from them.

8. Holistic:-B· Derived from the word "holism", holistic, refers to a biological concept that views the whole of a complex system such as a cell or organism, as functionally greater than the sum of its parts Holism is also known as organicism.



9. Astigmatic:-C· Astigmatism is a common eye-defect People with astigmatism cannot focus horizontal and vertical lines to the same point. This makes reading difficult Astigmatism occurs due to lack of symmetry in the curvature of the cornea or much less commonly of the crystalline lens (the cornea is the transparent wall of the eye, in front of the pupil and iris.) The result is blurring of part of the image on the retina (the light-sensitive tissue lining the back and sides of the eyeball) Astigmatism can also be produced by misalignment of the lens It is measured by an astigmatometer. Correction of vision is achieved with cylindrical lenses - lenses with one side flat and the other concave or convex in the shape of the cylinder wall

10. Ballistic:-A: Refers to a branch of applied mechanics, dealing with the motion and behaviour characteristics of missiles, that is, projectiles, bombs, rockets, guided missiles and so forth Ballistics is an important aspect of defense studies

Win a Prize

OUR list of 'tic' klish teasers are merely meant to en'tic'e you to join our December quiz competition We want you to send in a list of as many words mundane and exo'tic' as you can think off They must all end in 'tic' The list should contain only scientific terms and should be sent to our Bombay office·

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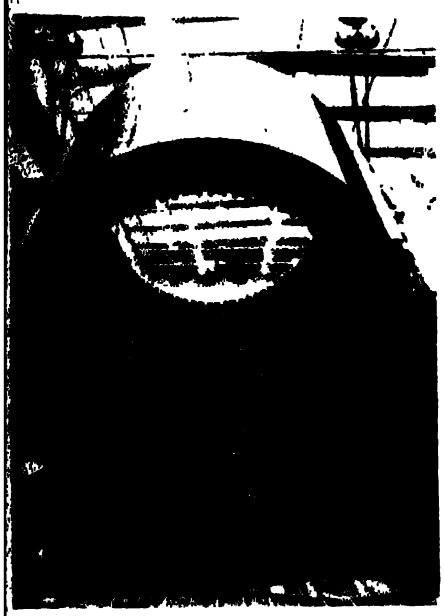
Testing with impulse generator



The impulse generator—the world's largest—is required for testing high-voltage circuit-breakers

The world's largest impulse generator, which delivers a short-circuit power of almost 6000 MVA, is at present being assembled in the high-power testing laboratory of the Berlin Schaltwerk in the Federal Republic of Germany (FRG). From about the middle of 1985 onwards, when this work will have been completed, the Schaltwerk will have the world's largest high-power testing laboratory for high-voltage circuit-breakers and switchgear. High-voltage circuit-breakers with breaking capacities of up to 120,000 MVA can thus be tested. This corresponds to the total installed capacity of all power stations in the FRG.

Such enormous capacities are essential for the testing and further development of modern high-voltage circuit-breakers and switchgear in order to meet future demands for high-capacity supply systems. Manufactured in about 100,000 man hours, the machine weighs 725 tonnes. The capital cost of the complete extension of the high-power testing laboratory will amount to nearly Rs 275 crores.

The 40-tonne supramagnet is a part of an international project for fusion research

Largest supraconductive magnet

The largest supraconductive magnet ever designed and built in the Federal Republic of Germany, left for the Oak Ridge National Laboratory in Tennessee, USA recently. This 40-tonne supramagnet is part of an international project for fusion research known as the "Large Coil Task" (LCT). The magnet will be assembled with five others—three from the USA and one each from Japan and Switzerland respectively—to form a ring coil arrangement.

The object of the LCT project is to demonstrate the industrial feasibility and operational safety of different designs of huge supraconductive toroidal field magnets with their typical huge D-shaped contour.

Before shipping to the USA the first function tests of the coil will be carried out in a 9 m high cryostat with a diameter of 5 m at the Institute for Technical Physics of the Karlrushe Nuclear Research Centre. The magnet will then be cooled down to the operating temperature of 4°K and energized with currents up to 10,000 amperes. The cryostat is installed in a pit 12 m deep and 10 m in diameter to reduce the intensity of the stray field.

The ultimate object of these efforts is directed to practical nuclear fusion, that natural process on our Sun by which the nuclei of hydrogen atoms are fused to form helium, thus releasing tremendous quantities of energy. It is hoped that this will prove to be the solution to almost all our future energy problems.

Savoury soyabean

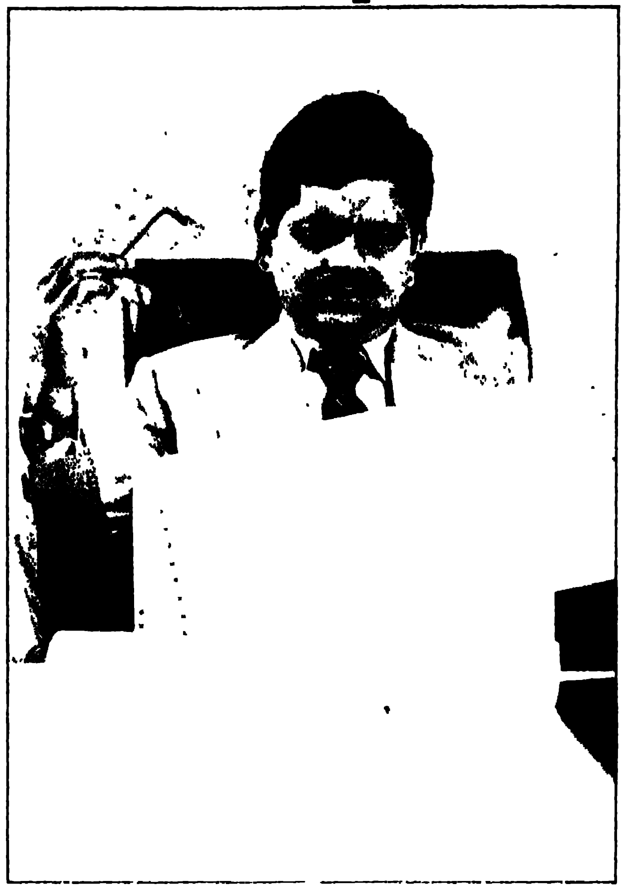
Soyabean is continuing to prove its versatility (see SCIENCE TODAY, September 1984). Recently, it has made inroads into the realm of coconut. The Soyabeans Food Research Centre of Sri Lanka has developed a soyabean substitute for coconut milk to counter the ever-escalating prices of coconut.

Soya flour, the Centre reports, mixed with 15 per cent dessicated coconut, effectively substitutes coconut milk in various dishes. Soya flour is made by extruding the beans and this is then mixed with dessicated coconut and ground to a fine powder.

The new product imparts the same flavour to dishes as that of coconut and it is virtually impossible to differentiate between the dishes made with the new product and those with 100 per cent coconut milk, the Centre claims.

While preparing gourd-type vegetables, the milk of soya powder can be directly added. But for cooking fish, meat, etc., the powder should first be dissolved in warm water.

The Eiko home computer



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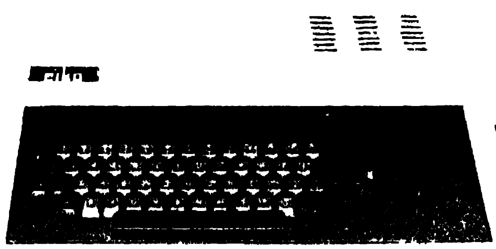

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A 'Synthetic' Stalwart

Proteins constitute the essential components of life. They, in turn, are made up of long chains of amino acids. Twenty-six letters of alphabet in various combinations and lengths make up entire English literature. Likewise twenty different amino acids join together in different ways to form peptide chains which fold and combine to build proteins. Until very recently only nature manufactured these. The natural process, although elegant and precise is quite complicated, the

R. Bruce Merrifield

ordered sequence of amino acids being dictated by the nucleic acid code. For devising a process which allows an automated synthesis of proteins *in vitro* Robert Bruce Merrifield was awarded the 1984 Nobel Prize fo Chemistry.

Even before Merrifield, scientists had tried to manufacture proteins in laboratory The steps involved were. (1) protection of amino acid carboxyl group,(2) formation of peptide bond, (3) selective removal of the amino terminal protecting group, (4) elongation of the peptide chain by repeating steps (2) and (3), and finally (5) removal of all protecting groups This strategy is called stepwise elongation

In order to ensure that all the new peptide bonds possess the linkage, the reactive side chains of amino acid residues have also to be blocked during the synthesis by stable chemical groups that can be removed after the synthesis.

For the successful synthesis of a peptide, all the coupling steps should be complete and none of the treatments during the progress of synthesis should lead either to racemization or to alteration of any side chains. Till 1963, all these reactions had to be carried out in appropriate solvents, and the products at each stage had to be purified by crystallization.

In 1963 Merrifield introduced a new concept in the synthesis of peptides. In this scheme, a suitable solid support was selected and a reactive site was produced on it. In the early experiments styrene polymer beads with chloromethyl groups as cross-linking groups, were used. The first amino acid—actually the terminal amino acid of the proposed peptide chain—was attached by its carboxyl group to the reactive site. The second amino acid, with all but one of its reactive groups protected was activated and coupled to the first amino acid, leaving the protected dipeptide firmly bound to the support The solid could be filtered and washed thoroughly. An automated process, at the press of a button or control valve could remove all the excess reagents and any by-products without the slightest danger of losing the desired peptide.

After the requisite sequence of amino acids was assembled in this manner the peptide chain could finally be removed from the support by selectively breaking the bond that has been holding the two together througout the synthesis. At this stage the peptide chain was free and could be dissolved and separated from the solid support Once it was in solution, conventional purification procedures were followed.

Since the early experiments, considerable progress has been made in the choice of solid supports, etc The stage is set for the synthesis of any high molecular weight protein. In 1963, insulin, a small protein with two peptide chains of 21 and 30 amino acids was synthesized in Germany, U S A and China. In 1965, the same molecule was synthesised in Merrifield's laboratory using automated solid phase peptide synthesizer It is to be hoped that molecules related to insulin would be prepared in the near future which may exhibit greater or more prolonged activity for the treatment of diabetes. It may also be possible that new and more efficient synthetic enzymes may be found, for certain biological functions or these may contribute in understanding the mechanism of the enzyme functions in relation to their structures.

A.S.U. Chaughuley

Dr Chaughuley is a senior scientist at the Bio Organic Division, Bhabha Atomic Research Centre, Bombay

The 'charmed' pair

THIS year's Nobel Prize in Physics is shared by two high energy physicists—Carlo Rubbia and Simon van der Meer, both from CERN, the European Centre for Nuclear Research, Geneva. Rubbia, born in Gorizia, Italy, has been awarded the Nobel Prize for the discovery in 1983 of *W* and *Z particles*. Van der Meer, born in The Hague, the Netherlands, has been so honoured for his invention of the *stochastic beam-cooling* method for the *accumulation of intense antiproton beams* which made the discovery of the W and Z particles possible. The W and the Z vector bosons (bosons are a class of particles named after the Indian physicist, S N Bose) were among the most elusive particles known.

Until some years ago, it seemed that nature was driven by four forces (i) the electromagnetic force (governing the interactions of electrically charged particles), (ii) the weak force (responsible for radioactivity and decay of many particles), (iii) the strong force (holding nuclei together and responsible for production of many particles in, for example, collision between two protons, and (iv) gravity (attracting large bodies). A very important theoretical concept is that each of these forces acts through the exchange (carrier) of a particle. Just as the photon, the ultimate quantum of light, is the carrier of the electromagnetic force, the newly discovered W and Z particles carry the weak force.

In their attempts to unify the basic forces, physicists have recently succeeded in unifying the electromagnetic and weak forces into a single basic force called *electroweak*. The electroweak theory was developed by Sheldon Glashow, Abdus Salam and Steven Weinberg for which they shared the 1979 Nobel Prize. The theory postulates the existence of three massive 'intermediate vector bosons', also called 'weakons'—one neutral (devoid of electric charge), the Z^0, and two electrically charged, the W^+ and W^-; the predicted masses of the W and Z^0 particles are 83.0±2.9 GeV and 93.8±2.5 GeV, respectively, that is, they are about as heavy as a nucleus of strontium. The discovery of the W and Z particles therefore provides a great support to our understanding of the electroweak force.

To detect and establish the existence of massive particles such as W and Z is not a trivial task. The basic process allowing the study of particles and their properties is the collision between accelerated particles. However in the late 1970s, such heavy particles were beyond the energy range of any existing machine. The most efficient machine for this purpose is undoubtedly the collider. A collider is generally a circular machine which accelerates a beam of particles and smashes it against another beam circulating in the opposite direction. A collider in which one of the beam is that of antiprotons and the other that of protons is more efficient for the production of W and Z particles than the one in which both the beams consist of protons. The CERN collider used by Rubbia and his team for the discovery of the weakons was precisely of the former kind. In this collider, antiprotons with energy of 270 GeV are made to collide against protons of 270 GeV energy, that is, a total of 540 GeV energy is available in the collision.

Carlo Rubbia

Simon van der Meer

Rubbia was the driving force behind this whole project. It was he who, in 1976, proposed (with David Cline and Peter McIntyre) the modification of existing accelerators into proton-antiproton colliders, initially at Fermilab in the US where it was rejected, and later at CERN. Credit must also go to the CERN management which showed the courage and foresight to accept this proposal at a fairly heavy cost in money and in dislocation of the experiments already underway.

This technological development could not, however, have been possible without the invention of 'stochastic cooling' by van der Meer. Rubbia says "We couldn't have done it without van der Meer." The problem van der Meer has solved is briefly this. Antiprotons are created in the collision of a high energy proton beam with a target, and collected into a rough beam. These antiprotons have a wide spread of velocities, and so cannot be accelerated coherently in a synchrotron accelerator. The velocity spread has to be narrowed, that is, the beam has to be 'cooled'. The word 'stochastic' means random, and 'stochastic cooling' works by reducing the random spread in velocities so that they become concentrated around the desired velocity. It does this by observing the 'centre of gravity' of a slice of the beam, using pick-up electrodes at one point of the ring. Signals are then sent across the ring to apply an electric field to the same slice of the beam when it has travelled around so as to nudge the 'centre of

gravity' towards the desired position. This procedure is repeated millions of times, progressively cooling the beam. It took four years, 1974-78, of experimentation by van der Meer and his team to demonstrate that these ideas were sound and could be used to obtain antiproton beams of sufficient intensity to do colliding beam physics at the CERN Super Proton Synchrotron.

Rubbia pushed hard against great odds and uncertainties to use these ideas to build the 540-GeV antiproton-proton collider, mentioned earlier. Furthermore, he pulled together a large team to put forward a proposal for an experiment which was code-named UA1, after 'Underground Area' where the massive detector is housed. This team grew to involve some 130 physicists from 13 research centres, mostly from Europe. The UA1 consists of an assembly of about 2,000 tonnes of detector apparatus capable of identifying particles and measuring their energies. By a careful analysis of the electronically recorded events, the UA1 announced the discovery of the W^+ and W^- in January 1983 and of the Z^0 in May 1983. Thus the quest for the intermediate vector bosons, begun in the early 1960s and pursued vigorously at every accelerator commissioned since then, finally came to an end at the CERN antiproton-proton collider.

P.K. Malhotra

Prof Malhotra is with the Tata Institute of Fundamental Research, Bombay

The 'immortal' trio

Niels Jerne

'MONOCLONAL antibody' has become almost a password in biological sciences today. Far beyond their original aim, they have found ever-increasing applications in almost every single branch of life sciences. They have also become important weapons in treating and diagnosing disease. For this epoch making discovery and ushering in of the hybridoma technology, its originators Cesar Milstein and George Kohler share this year's Nobel Prize for Physiology and Medicine along with the leading theoretician of immunology, Niels Jerne.

Niels Kaj Jerne (73), has been fondly considered as 'a man who not only studied immune system, but who patterned his life after it'. Born in London and educated in Holland, Jerne studied medicine in Copenhagen rather late in life. He wanted to become a village doctor. However, during his studies he took up a part time job in a scientific laboratory, and 'from then on', he says, '(he was) trapped in science'.

Jerne is a conceptualist, who has provided two very important concepts in immunology, that of self tolerance, and of network theory.

The whole immune system revolves around the fact that the body is capable of reacting only to 'foreign' substances invading the host. The question is, what decides this foreignness? Jerne provided an elegant theory to explain this discriminatory ability of the host. He postulated that during very early development (ontogeny), clones of lymphocytes reacting to 'self' molecules are eliminated (forbidden clones). This postulate has helped in linking up the remarkable phenomenon of antibody diversity with self-tolerance.

The regulation of immune response has been the subject of detailed investigation for several years. Proliferation of lymphocytes triggered during immune response, if not adequately controlled, might lead to autoimmune diseases or malignancy. Jerne's network theory envisages the presence of lymphocytes having recognition molecules or 'fits' for each of the diversified antibody molecule a host is capable of producing in response to any antigen. Thus, to a vast number of antibody molecules of diverse specificities, there exist cells capable of producing 'anti-antibody'.

If not for his theoretical exploits, Jerne would certainly be remembered for his gift to immunologists of the most widely used technique of 'plaque formation' which helps visualisation of individual antibody-producing cell.

The major dilemma in the immune system is that the antibody-producing cell has a finite life, which limits the availability of this important biological reagent. It is also difficult to produce antibodies of desired specificities at will. One of the greatest scientific contributions of the last decade is the development of a methodology to immortalise the antibody-producing cell by fusing it with a cell that has a capacity to grow continuously in tissue culture. The originators of this ingenious methodology are George Kohler and Cesar Milstein.

According to Milstein, any modern scientific discovery is an outcome of a whole lot of background work conducted in the past by several scientists. In this instance, he gives equal credit to the development of the method of tissue culture, somatic cell hybridization, and the clonal selection theory of antibody production. The combination of all these is the birth of

the 'Hybridoma Technology' which has already changed the complexion of many a biological science and medicine.

Born in Argentina, Cesar Milstein had his doctorate both at Buenos Aires (1957) and at Cambridge (1960) After making a sincere but futile attempt at working as a faculty member at Buenos Aires, he returned to Cambridge in 1963, and is at present a senior member of the British Medical Research Council Laboratories of Molecular Biology.

which the antibody is directed He first brought about a fusion between two myeloma cells, which helped him understand structural details of antibody molecules and genes involved in their synthesis However, in order to relate the structure of an antibody molecule with its function, he needed a continuous supply of antibody with known specificity

Around this time, George Kohler, a young German joined the group After a great deal of deliberation, the younger scientist won, and the idea of

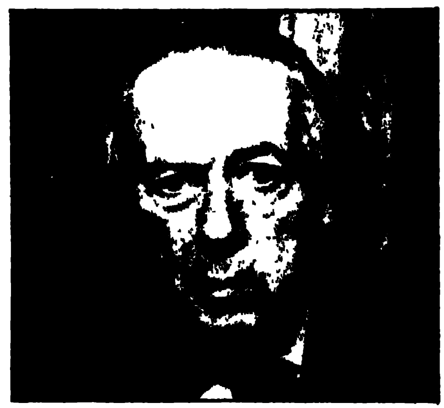
benefit? He feels that no discovery belongs to individual scientists, it is a combined effort of the group working in the laboratory, and all the previous discoveries which are the integral part of the new discovery. To, 'Did you not realize the economic importance of your discovery,' Milstein says, 'Yes we did, but we did not guess the number of zeros involved in the estimate'

Sudha G. Gangal

Dr (Smt) Gangal is Head, Immunology Division, Cancer Research Institute, Bombay

George Kohler

Cesar Milstein



Richard Stone

Milstein started his career under very meagre laboratory conditions in Buenos Aires with only 5-litre flasks (of which he broke 3) and the only piece of equipment being the Warburg Apparatus Under these circumstances, he did some outstanding research on aldehyde dehydrogenase enzyme and earned a fellowship to work at Cambridge where he had an opportunity to work with the two time nobel prize winner Fred Sanger, determining amino acid sequences of enzymes

He started his work on antibodies in Cambridge in 1963, when, in his own words, his 'ignorance of Immunology was absolute' His basic interest was to sequence the antibody molecule thus starting the era of molecular immunology. For this purpose, he grew the mouse myeloma cells(tumor of antibody-producing cells)in tissue culture. Myeloma tumor cells secrete antibody. However, it is virtually impossible to identify the antigen to

fusion between an antibody-producing cell from mouse immunized against a known antigen and a myeloma cell was born The ingenuity of this technique lies in the fact that a hybrid between antibody-producing cell and myeloma receives the ability to grow indefinitely from the myeloma cell and the ability to produce antibody from the immune lymphocyte This procedure thus fixes antibody producing genes in a continuously growing cell The source of uniform antibody preparation with specified reactivity thus obtained has a potential to provide a remarkably versatile tool in many areas of fundamental research and in medicine

Milstein however feels that the success of their first fusion experiment was, to a large degree, due to good luck. When asked why they did not patent their discovery, Milstein expressed very strong views. Who owns scientific discovery, and who should

An 'inquisitive' economist

AWARDING the Nobel Prize in Economics this year to Sir Richard Stone of Cambridge University, UK, the Swedish Academy of Sciences cited his 'fundamental contributions to the development of systems of national accounts and thus greatly improving the basis for empirical economic analysis' Stone (71) has been Leake Professor of Finance and Accounting at Cambridge since 1955

Writing in a reflective mood in 1980, Stone had grouped economic specialists in three categories the 'speculative try to make deductions about the economy's working from observed signals, the 'active' do not like the way

Continued on page 80

SCIENCE TODAY

Volume 18
January-December 1984

Figures in italics denote issue numbers

NOBEL PRIZES

Continued from page 77

it appears to work and try to devise improvements, and the 'inquisitive' go to the brass tacks and try to see how the economy actually works Stone unhesitatingly classifies himself in the last category, while many economists would tend to agree with this self-assessment, it does considerably less than full justice to his life work, for Stone has often cast himself in the other two roles as well

Stone's major area of interest has been national income analysis The measurement of the total income of a country has been a subject of considerable interest to social thinkers and political leaders alike ever since the emergence of nation states But paucity of data had largely frustrated such work In the 20th century, researchers like Colin Clark in the UK, Simon Kuznets in USA, Ragnar Frisch in Norway, and van Cleeff in Holland (to name a few) did pioneering work in the construction of national income and production statistics Their herculean efforts were largely responsible for underlining the importance of such statistics to policy-making organs of governments. Effective economic planning presupposes detailed information on various economic aspeets, of which national income accounts forms the' most important component

By 1960, almost all countries were publishing official national income statistics more or less regularly Much of Stone's early work was devoted to evolving a standardised system of national accounts for different countries The United Nations manual, *A System for National Accounts* (which constitutes a very useful guideline worldwide)bears a deep imprint of Stone's fundamental contribution in this area

Stone's name is closely linked to the concept of 'social accounting' The national accounts present details about income and related magnitudes such as savings and investment While extremely useful by themselves, such accounts do not yield all the information that we require for understanding the complex working of economic systems The need to be supplemented, on the one hand, by what are called input-output tables, which describe the flows of goods between the various production sectors of an economy and, on the other, by the so-called flow-of-funds tables which depict the sources and uses of finance 'Social accounting' is concerned with the synthesis of these three parallel streams of analyses, and owes much of its development to work by Stone and his associates In recent years, Stone has been attempting to incorporate regional and demographic dimensions into the 'social accounting' framework

Stone's researches in the area of national income analysis also led him to adjacent fields such as consumer demand estimation Here his main contribution is the 'linear expenditure system' which has served as the basis for most of the empirical work in this area Stone had an abiding interest in problems of growth and planning He was the motive force behind the 'Cambridge Growth Model' which is a largescale detailed econometric model of the UK and which has seen considerable use as a prediction and policy tool Stone was sympathetic to the problems of developing countries and was one of the experts called by Jawaharlal Nehru to advise in the early stages of the Indian planning experiment Stone had thus an essential 'active' dimension too to his personality

Stone can on occasions don the garb of a 'speculative' philosopher His forays into the mathematical theories of trade cycles and optimal growth, into economic history and political economy have produced thought-provoking articles which are eloquent testimonials to his talents in this direction

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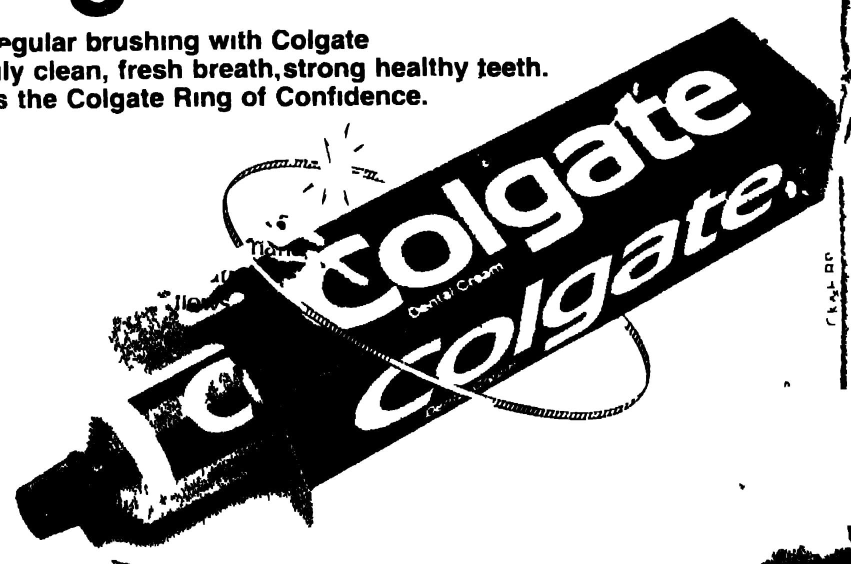

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